Statistical Methods for Metrological Control

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Contents

1. Scope

1.1 General

This document establishes definitions for the administrative and statistical terms used throughout the document series S-S-XX: *Statistical Methods for Metrological Control*. It also defines symbols for a limited number of these terms.

1.2 Application

Throughout this document, definitions for the various terminology are constructed with the use of general terms such as item, unit, product, and service. Other documents in the series may use the vocabulary with the substitution of more specific terms. In these cases, the definitions in this document apply in the narrower sense indicated by the substituted terms.

1.3 Organization

1.3.1 The vocabulary in this document has been divided into five major groupings:

(a) general terms pertaining to administration and measurement;

(b) terms relating to quality;

(c) terms relating to probability theory;

(d) general statistical terms; and

(e) terms relating to sampling and sampling inspection.

1.3.2 Terms are presented in each section of this document in a sequential manner such that any individual term may be interpreted on the basis of preceding terms where appropriate.

1.3.3 Definitions of the various symbols used in the application of statistical methods are also provided.

2. General Terms

2.1 Administration

2.1.1 Act : The *Electricity and Gas Inspection Act* or the *Weights and Measures Act*, as the case

may be.

2.1.2 Regulations : The *Electricity and Gas Inspection Regulations* or the *Weights and Measures Regulations*, as the case may be.

2.1.3 Specifications : The specifications established pursuant to the Act or Regulations for the purpose of inspecting, verifying, or certifying the quality of meters, measuring devices, or other measurement-related products.

2.1.4 meter; measuring device : Any apparatus used for the purpose of making measurements of, or obtaining the basis of a charge for, a commodity supplied to a purchaser.

2.1.5 Director : The President of Measurement Canada.

2.1.6 government inspector : Any officer appointed under the authority of the Act.

2.1.7 metrological verification : All the operations carried out by an inspector or an accredited meter verifier having the object of ascertaining and confirming that a meter entirely satisfies the requirements of the Specifications. It includes both the inspection and sealing of meters.

2.1.8 accreditation : The formalized initial and continuing recognition by the Director of an organization's ability to implement and maintain a quality assurance system for measurement products and services.

2.1.9 accredited meter verifier : An organization which has received accreditation in a specific field, or in specific fields, of metrological verification.

2.1.10 quality assurance inspector : A qualified person who is designated in an accredited meter verifier's quality assurance manual as being responsible for independent inspection of product or service quality.

2.1.11 inspector : When the term is used unmodified, a government inspector or a quality assurance inspector.

2.1.12 owner : The party who has title to the product being produced or who is responsible for the service being provided, and includes any representatives, agents, or subcontractors acting in a legal capacity on behalf of the owner.

2.2 Measurement

2.2.1 measurement : The set of operations having the object of determining the value of a quantity.

2.2.2 metrology : The field of knowledge concerned with measurement.

2.2.3 metrological control : Control exercised by the responsible authorities and relating to the methods and means of measurement used and the conditions under which the results of measurements are obtained, expressed, and used.

2.2.4 accuracy (of measurement) : The closeness of agreement between the result of a measurement and the (conventional) true value of the quantity subjected to measurement.

2.2.5 precision (of measurements) : The closeness of agreement between the results obtained by applying the experimental procedure several times under prescribed conditions.

2.2.6 repeatability (of measurements) : The closeness of agreement between the results of successive measurements (of the same quantity) obtained with the same method of measurement, under the same conditions (same observer, same measuring instrument, same location, and over short intervals of time).

2.2.7 reproducibility (of measurements) : The closeness of agreement between the results of individual measurements (of the same quantity) obtained with the same method but under different conditions (different operators, different measuring instruments, different locations, or different time).

2.2.8 uncertainty (of measurement) : An estimate characterizing the range of values within which the true value of a quantity subjected to measurement lies.

2.2.9 metrological parameter (of a meter) : A design characteristic which specifies the meter's minimum, maximum, or range of measurement for a measurable quantity.

2.2.10 measurement standard : A device or instrument used as a reference for the calibration or quantification of a product's metrological properties or characteristics.

2.2.11 damaged meter: A meter which has been subjected to a disturbance in the form of mechanical shock, electrical shock, or chemical alteration. The disturbance may have affected the meter's metrological or technical characteristics.

3. Terms Relating to Quality

3.1 Quality Systems

3.1.1 quality : The totality of features and characteristics of products or services that bear on their ability to meet specified requirements.

3.1.2 quality control : All of the actions which provide a means to measure and regulate the characteristics of products or services to specified requirements.

3.1.3 quality assurance : All of the planned and systematic actions needed to provide adequate confidence that products or services will satisfy specified requirements.

3.1.4 quality assurance manual : A document which contains an organization's policies and procedures with respect to assuring product or service quality.

3.1.5 inspection : The process of measuring, examining, testing, gauging, or otherwise comparing the unit with the applicable requirements.

3.1.6 independent inspection : Inspection by a qualified person identified in a quality assurance manual who is responsible for inspecting product or service quality and who does not perform or directly supervise the work being inspected and does not report directly to immediate supervisors responsible for producing the work being inspected.

3.1.7 verification : The process of independently reviewing, examining, testing, measuring, monitoring, or otherwise establishing and documenting that products, processes, services, and documents conform to specified requirements.

3.1.8 calibration : The process of comparing two instruments, measuring devices, or standards, one of which is of known accuracy. It is done to detect, correlate, report, or eliminate by adjustment any variation in accuracy of the instrument or measuring device of unknown accuracy.

3.1.9 nonconformance : A deficiency in characteristic, documentation, or procedure which renders the quality of a product or service unacceptable.

3.1.10 disposition : An action taken to resolve a nonconformance.

3.1.11 corrective action : An action taken to resolve a nonconformance, including all steps taken to prevent recurrence of the nonconformance.

3.1.12 audit (or **quality audit**) : A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

3.1.13 auditee : The organization subjected to audit.

3.1.14 auditor : A person or team qualified to plan and conduct audits of systems, processes, or products, and includes, as necessary, the auditor's management.

3.1.15 product : A result of activities or processes, which includes such things as measuring devices, parts, services, hardware, software, processed materials, information, or combinations thereof.

3.1.16 product quality audit (or **product audit**) : An in-depth, independent examination and

evaluation of the quality system as it applies to a particular product. It involves examination of all elements of the product and their related quality system elements to evaluate the system against the referenced standards or specifications for that product.

3.2 Quality Events

3.2.1 characteristic : A property which helps to differentiate between the items of a given population. The differentiation may be either quantitative (by variables) or qualitative (by attributes).

3.2.2 qualitative characteristic : A characteristic which is measurable on a discrete scale.

3.2.3 quantitative characteristic : A characteristic which is measurable on a continuous scale.

3.2.4 quality characteristic : A characteristic of a product or service which is subject to quality control.

3.2.5 event : An occurrence of some attribute.

3.2.6 nonconformity : A departure of a quality characteristic from its intended level or state that occurs with a severity sufficient to cause an associated product or service not to meet a specification requirement.

3.2.7 nonconforming unit : A unit of product or service containing at least one nonconformity.

3.2.8 serious nonconforming unit : A unit of product or service containing one or more nonconformities of an extreme nature.

3.2.9 defect : A departure of a quality characteristic from its intended level or state that occurs with a severity sufficient to cause an associated product or service not to satisfy intended normal, or reasonably foreseeable, usage requirements.

3.2.10 defective; defective unit : A unit of product or service containing at least one defect, or having several imperfections that in combination cause the unit not to satisfy intended normal, or reasonably foreseeable, usage requirements.

3.2.11 tolerance zone : The zone of values in which a measurable characteristic is in conformity with its specification.

3.2.12 tolerance limit : The limiting value (lower or upper) specified for a quantitative characteristic.

4. Terms Relating to Probability Theory

4.1 General

4.1.1 random variable; variate : A variable which may take any of the values of a specified set of values and with which is associated a probability distribution.

4.1.2 probability distribution of a random variable : A function which determines the probability that a random variable takes any given value or belongs to a given set of values. The probability on the whole interval of variation of the variate equals 1.

4.1.3 distribution function : A function giving, for every value x, the probability that the random variable X be less than or equal to x:

$$F(x) = Pr\{X \leq x\}$$

4.1.4 probability density function for a continuous random variable : The derivative (when it exists) of the distribution function:

$$f(x) = \frac{dF(x)}{dx}$$

4.1.5 bivariate distribution : A distribution which determines the probability that a pair of variates takes any given values or belongs to a given set of values.

4.1.6 multivariate distribution : A distribution which determines the probability that several variates considered simultaneously take any given values or belong to a given set of values.

4.1.7 correlation : The inter-dependent relationship between two or several variates when such a relationship includes a random part.

4.2 Theoretical and Sampling Distributions

4.2.1 uniform distribution; rectangular distribution : The probability distribution of a continuous variate for which the probability density function is constant within a finite interval and zero outside this interval.

4.2.2 normal distribution : The probability distribution of a continuous random variable X such that, if x is any real number, the probability density is:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

4.2.3 chi-squared distribution : The distribution of the sum of the squares of independent standardized normal variates. The number of these variates is the number v of degrees of freedom of the χ^2 distributed variate, a parameter of the distribution. The probability density function of the χ^2 distributed variate is:

$$f(\chi^2, v) = \frac{(\chi^2)^{\frac{v}{2}-1}}{2^{\frac{v}{2}}\,\Gamma\left(\frac{v}{2}\right)} e^{-\frac{\chi^2}{2}}$$

4.2.4 *t*-distribution : The distribution of a quotient of independent random variables, the numerator of which is a standardized normal variate, and the denominator of which is the positive square root of the quotient of a χ^2 distributed variate and its number of degrees of freedom. The number of degrees of freedom of χ^2 is the number v of degrees of freedom of the t-distributed variate. The probability density function of the t-distributed variate is:

$$f(t, v) = \frac{\Gamma\left(\frac{v+1}{2}\right)}{\sqrt{\pi v}\left(1 + \frac{t^2}{v}\right)^{\frac{v+1}{2}}\,\Gamma\left(\frac{v}{2}\right)}$$

4.2.5 *F*-distribution : The distribution of the quotient of two independent χ^2 distributed variates, each one divided by its number of degrees of freedom. The numbers of degrees of freedom of the χ^2 distributed variates of the numerator v_1 and of the denominator v_2 are, in this order, the numbers of degrees of freedom of the F-distributed variate.

4.2.6 binomial distribution : The probability distribution of a discrete random variable such that, if $x \in \{0, 1, 2, ..., n\}$, then

$$Pr[X = x] = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x} \; ; \; 0 < p < 1$$

4.2.7 hypergeometric distribution : If three positive or null integers N, n, and d are given such that the numbers in the table below are positive or null integers,

N	d	$N - d$
n	x	$n - x$
$N - n$	$d - x$	$N - n - d + x$

then

$$Pr[X = x] = \frac{n!\,(N-n)!\,d!\,(N-d)!}{N!\,x!\,(n-x)!\,(d-x)!\,(N-n-d+x)!}$$

5. General Statistical Terms

5.1 General

5.1.1 item; unit : An actual or conventional object on which a set of observations may be made.

5.1.2 population : The totality of items under consideration.

5.1.3 population parameter: A quantity used to describe the distribution of a characteristic in the population.

5.1.4 characteristic : A property which helps to differentiate between the items of a given population. The differentiation may be either quantitative (by variables) or qualitative (by attributes).

5.1.5 test : An operation made in order to measure or classify a characteristic.

5.1.6 observed value : The particular value of a characteristic determined as a result of a test or measurement.

5.1.7 observation : A result of the process of determining the presence or absence of attributes or making a measurement of a variable.

5.1.8 outlier; outlying observation : An observation that appears to deviate markedly from other observations in the sample in which it occurs.

5.1.9 class : In the case of quantitative characteristics, each of the consecutive intervals into which the total interval of variation is divided.

5.1.10 absolute frequency : The number of items (of a population, lot, sample, class, and so on).

5.1.11 relative frequency : The ratio of the number of times a particular value (or a value falling within a given class) is observed to the total number of observations.

5.1.12 frequency distribution : The relationship between the values of a characteristic and their absolute or relative frequencies.

5.2 Statistical Measures

5.2.1 count : The number of events of a given classification occurring in a sample.

5.2.2 arithmetic mean : The sum of values divided by their number.

5.2.3 variance : A measure of the dispersion based on the mean squared deviation from the mean.

5.2.4 standard deviation : The positive square root of the variance.

5.2.5 skewness : A measure of the symmetry of a distribution.

5.2.6 kurtosis : A measure of the shape of a distribution.

5.2.7 statistic : A function of the observed values derived from a sample.

5.2.8 order statistic : When the values in a sample are arrayed in order of algebraic magnitude, each of these ordered values is known as an order statistic. More generally, any statistic based on order statistics in this narrower sense is also called an order statistic.

5.2.9 summary value : A value which describes the characteristics of a sample. It may take the form of a statistic when quantitative data are involved or a count when either quantitative or qualitative data are involved.

6. Terms Relating to Sampling and Sampling Inspection

6.1 Sampling

6.1.1 sample : One or more items taken from a population and intended to provide information on the population and possibly to serve as a basis for a decision on the population or on the process which had produced it.

6.1.2 sampling : The procedure used to draw or constitute a sample.

6.1.3 sampling unit : For the purpose of sampling, an item or, in a multistage sampling, a group of items, taken from the population.

6.1.4 sampling without replacement : A method of sampling in which items are taken from the population once only or successively without being returned to the population.

6.1.5 random sampling : The taking of n items from a population of N items in such a way that all possible combinations of n items have the same probability of being chosen.

6.1.6 pseudo-random sampling : The process of selecting a sample in accordance with an algorithm which simulates the properties of a random sampling process.

6.2 Sampling Inspection

6.2.1 lot; homogeneous lot : A definite quantity of some commodity manufactured or produced under conditions which are presumed uniform.

6.2.2 statistical quality control : Quality control using statistical methods (such as control charts and sampling plans).

6.2.3 sampling plan : A specific plan that states the number of units to be inspected and the associated decision criteria.

6.2.4 sampling inspection : The inspection of a limited number of units, or of a limited quantity of material, taken at random from the lot or process according to a prescribed sampling plan.

6.2.5 acceptance sampling : Sampling inspection in which decisions are made to accept or reject product or service. The object is to ensure that lots of acceptable quality have a high probability of acceptance.

6.2.6 compliance sampling : A specialized form of acceptance sampling having the object of ensuring that lots of unacceptable quality have a high probability of rejection.

6.2.7 single sampling : A type of sampling which consists in taking only one sample per lot.

6.2.8 double sampling : A type of sampling which consists in taking possibly a second sample according to the information given by the first.

6.2.9 original inspection : The first inspection of a lot as distinguished from the inspection of a lot which has been resubmitted after previous non-acceptance.

6.2.10 100% inspection : Inspection of all the items or of the whole material in a lot.

6.2.11 inspection by attributes : A method which consists in taking note, for every item of a population or of a sample taken from this population, of the presence or absence of a certain qualitative characteristic (attribute) and in counting how many items have or do not have this characteristic.

6.2.12 inspection by variables : A method which consists in measuring a quantitative characteristic for each item of a population or of a sample taken from this population.

6.2.13 inspection level : A characteristic of a sampling plan, chosen in advance and connecting the size of the sample(s) to the lot size.

6.2.14 probability of acceptance : The probability that a lot of a given quality will be accepted by a given sampling plan.

6.2.15 operating characteristic curve for a sampling plan (OC curve) : A curve showing, for a

given sampling plan, the probability of acceptance of a lot as a function of its actual quality.

6.2.16 acceptable quality level (AQL) : The maximum percentage of nonconforming units in a lot that, for the purposes of acceptance sampling, can be considered satisfactory as a process average.

6.2.17 limiting quality level (LQL) : A quality level, in a sampling plan, that corresponds to a specified and relatively low probability of acceptance.

6.2.18 acceptance number: In sampling inspection by attributes, the upper value of the number of nonconformities or nonconforming units found in the sample which involves the acceptance of the lot.

6.2.19 acceptability constant : In sampling inspection by variables, a constant dependent on the specified value of the acceptable quality level and the sample size.

6.2.20 maximum standard deviation (*MSD*) : In sampling inspection by variables, the largest acceptable standard deviation under given conditions.

6.2.21 quality statistic : In sampling inspection by variables, the value which is a function of the tolerance limit, the sample mean, and the estimate of the standard deviation of the lot.

7. Symbols

c the acceptance number which denotes the number of permissible nonconforming units within a sample.

f a factor that relates the maximum standard deviation to the difference between U and L.

g_1 the estimate from the sample of the skewness of the lot.

g_2 the estimate from the sample of the kurtosis of the lot.

k the acceptability constant.

k_i the acceptability constant corresponding to the upper ($i = 1$) or lower ($i = 2$) tolerance limit.

L the lower tolerance limit.

m the number of outliers (mavericks) found in a sample.

n the number of units in the sample.

n_{max} the maximum permissible number of units in a sample.

n_{min} the minimum permissible number of units in a sample.

N the number of units in the lot.

o the number of permissible outliers in a sample.

Q_L the lower quality statistic.

Q_U the upper quality statistic.

r the number of nonconforming units found in a sample.

r_s the number of serious nonconforming units found in a sample.

s the estimate from the sample of the standard deviation of the lot.

U the upper tolerance limit.

x_i the measured value of a characteristic corresponding to the i^{th} unit in the sample.

$\bar{x}$ the mean value of x_i for the sample of n units.

. "the sum of".

$\sum_{i=1}^{n} x_i$ the sum of all the x values when i takes integral values from 1 to n.

• "greater than or equal to".

• "less than or equal to".

> "greater than".

< "less than".

. "square root of".

'g' "the absolute value of an arbitrary variable g".

$n!$ "n factorial".

SECTION 02

Quality System Requirements

Contents

1. Scope

1.1 General

1.1.1 This document establishes the policies, procedures, and requirements of Measurement Canada regarding the authorization and on-going recognition of quality systems in support of the use of statistical methods in metrological control applications.

1.1.2 Compliance with all requirements defined in this document is a prerequisite to obtaining authorization to use statistical methods in metrological control applications.

1.2 Applicability

This document applies to all organizations seeking authorization to use statistical methods for assuring or controlling the quality of regulated characteristics of measuring devices and measurement-related products or services, either directly or indirectly through the employment of agents or subcontractors.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-05: *Statistical Methods for Metrological Control — Acceptance Sampling.*

S-S-06: *Statistical Methods for Metrological Control — Compliance Sampling.*

S-S-07: *Statistical Methods for Metrological Control — Product Quality Audits.*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

1.5.1 The responsibilities of organizations interested in obtaining and maintaining authorization to use statistical methods are:

(a) to develop and document quality system policies and procedures in accordance with the requirements of this document;
(b) to submit quality system documentation for Measurement Canada review and acceptance prior to implementation;
(c) to implement and maintain the documented quality system;
(d) to periodically evaluate the quality system, including those activities performed by suppliers, subcontractors, or other agents;
(e) to update quality system documentation and submit for re-evaluation when required;
(f) to provide Measurement Canada representatives with access to information, activities, or facilities to verify or audit compliance with the terms of the authorization;
(g) to promptly initiate corrective action on any potential or actual nonconformance identified as the result of audit or otherwise;
(h) to maintain quality records pertaining to the administration of the quality system;
(i) to provide any information required by Measurement Canada for the purposes of assessing on-going compliance; and
(j) to ensure that all additional responsibilities with respect to a specific statistical method defined elsewhere in the document series are met.

1.5.2 The responsibilities of Measurement Canada are:

(a) to review and evaluate applications submitted for authorization in accordance with the requirements of this document, and advise the applicant of the results;
(b) to grant authorization to organizations which have demonstrated compliance with the requirements of this document;
(c) to specify any conditions to which the granted authorization is subject;
(d) to perform reviews or audits of the implementation of the organization's quality system and advise the organization of the findings;
(e) to withdraw or revoke authorizations where warranted by the situation; and
(f) to ensure the on-going effectiveness of the requirements of this document with respect to the agency's mission.

2. Policies and Procedures

2.1 General

This section describes the policies and procedures of Measurement Canada with respect to the authorization of organizations to use statistical methods in metrological control applications.

2.2 Eligibility

Any Canadian organization willing to comply with the requirements established in this document may apply for authorization to use statistical methods for metrological control purposes.

2.3 Liabilities

2.3.1 An organization wishing to use statistical methods shall be liable for ensuring that the activities of all suppliers, service organizations, subcontractors, or other agents meet all requirements on an on-going basis, whether or not such agents are independently authorized by Measurement Canada for the performance of the said activities.

2.3.2 An organization supplying product or service involving the use of statistical methods shall clearly specify and document the distribution of liability between the organization and the customer of the product or service.

2.3.3 The end-user of a measurement product used in trade is ultimately liable for the product's compliance with legal requirements and shall ensure that systems are in place and are effective towards achieving and maintaining this compliance.

2.4 Application

An application for authorization to use statistical methods in metrological applications shall be made in writing to Measurement Canada by the organization seeking authorization and shall include:

(a) the name and address of the applicant organization;
(b) the name and contact details of the person representing the organization for the purposes of the application;

(c) details as to the types of statistical methods that will be used and the products and characteristics that will be evaluated by the statistical methods;
(d) details as to the relevant liabilities as referred to in clause 2.3; and
(e) one or more copies of the applicant's Quality System Manual referred to in clause 3.2.

2.5 Authorization Procedure Overview

2.5.1 The information supplied by the applicant will be reviewed for completeness in accordance with the requirements of clause 2.4.

2.5.2 The submitted Quality System Manual will be evaluated for adequacy and completeness with respect to the requirements of this document.

2.5.3 Authorization to use statistical methods will be granted in writing to the applicant when compliance with all of the relevant requirements specified in this document is ascertained. Any applicable terms and conditions will also be specified in the written authorization.

2.5.4 In the event that an application is incomplete or otherwise deficient, the applicant will be advised in writing of the areas requiring corrective action.

2.6 Maintenance of Authorization

2.6.1 Measurement Canada shall perform reviews of records and status reports from the authorized organization and, as appropriate, perform audits for the duration of the authorization to confirm continuing compliance with the requirements of this document.

2.6.2 An organization receiving authorization to use statistical methods may maintain its authorized status by continuing to implement the quality system as documented and authorized. Any change required in the administration or implementation of the quality system shall be documented by the organization and authorized by Measurement Canada before its implementation.

2.7 Termination of Authorization

2.7.1 In the case that non-compliance with the requirements cannot be resolved in accordance with Measurement Canada's policies, the organization's authorization shall be revoked in writing.

2.7.2 If the organization no longer requires the granted authorization, this fact shall be communicated in writing to Measurement Canada. In this case, the authorization shall be withdrawn in writing.

3. Quality System Requirements

3.1 General

3.1.1 This section defines and describes the requirements for a quality system for the use of statistical methods in metrological control applications.

3.1.2 The organization shall plan, establish, document, implement, and maintain a quality system according to the requirements of this section.

3.2 Quality System Manual

3.2.1 A Quality System Manual approved and signed by senior official who has organizational authority for the work within the scope of the quality system shall be prepared and submitted to Measurement Canada for acceptance.

3.2.2 The Quality System Manual shall include the following contents as a minimum:

(a) the scope of the quality system and the organization's broad quality policies in accordance the requirements specified in clause 3.3;

(b) a description of the organizational structure relevant to the management, performance, and verification of the work activities within the quality system, including definition of the responsibility and authority of personnel primarily responsible for quality assurance and identification of internal and agent personnel by position title, their specific responsibilities, and their reporting relationships through organizational charts;

(c) the system element policies specified in clause 3.3; and

(d) the administrative and technical procedures required by clause 3.4.

3.3 Quality Policies

3.3.1 Quality policies for the overall quality system and for planning and controlling the individual quality system elements defined in clause 3.5 shall be documented, implemented, and maintained.

3.3.2 The organization's policies for quality shall be written in clear, unequivocal language.

3.3.3 The organization's overall quality system policy shall express management's commitment for assuring that all of the activities covered by the quality system are performed in strict accordance with the documented quality procedures written for that purpose.

3.3.4 The organization's individual quality system element policies shall provide guidance to personnel with respect to the proper context and interpretation of the system element and associated procedures in relation to the overall quality system.

3.4 Quality Procedures

3.4.1 Quality procedures for planning and controlling the individual quality system elements defined in clause 3.5 and for performing all relevant technical activities shall be documented, implemented, and maintained.

3.4.2 The organization's administrative and technical procedures for quality shall be written in clear, unequivocal language with the goal of ensuring consistent user interpretation and application in the performance of the various work activities involved in the quality system.

3.4.3 Subject to clauses 3.4.4 to 3.4.7, each procedure shall be written in a uniform format to include the following sections and associated content:

(a) ***Purpose*** - a statement which describes the reason for creating the procedure;

(b) ***Scope*** - a statement which clearly specifies what the procedure pertains to;

(c) ***References*** - a list which itemizes other documents that the user of the procedure must have access to in order to properly apply the procedure;

(d) ***Definitions*** - statements which define any words, symbols, or jargon which have special meaning in the procedure (as much as possible, the use of jargon should be avoided);

(e) ***Apparatus*** - a list which identifies any equipment or measurement standards needed to perform any of the tasks required by the procedure;

(f) ***Procedure*** - a series of statements which define the logical sequence of instructions required to be followed to ensure that the user properly carries out the required tasks (refer to clause 3.4.4 for further information);

(g) ***Documentation*** - a list which identifies any documentation such as forms, test set-ups, wiring diagrams, illustrations, schematic drawings, or other useful information which are necessary to carry out the procedure and are normally included in the appendices; and

(h) ***Appendices*** - a compilation of the actual documentation identified in the "Documentation" section.

3.4.4 The instructions in the "Procedure" section may be supplemented where necessary with pertinent remarks. In administrative-type procedures where more than one person is responsible for implementing parts of the procedure, this responsibility shall be identified as well.

3.4.5 The section entitled "Apparatus" may be omitted in administrative-type procedures only.

3.4.6 The section entitled "Appendices" may be omitted where the procedure requires no entries under its "Documentation" section.

3.4.7 To preserve consistency in a procedure's format, wherever no information is required under a given section, the section heading shall be followed with the words "Not applicable."

3.5 Quality System Elements

3.5.1 Quality Planning

Procedures defining how the requirements for quality will be met, monitored, maintained, and reviewed shall be documented.

3.5.2 Contract Review

Procedures defining how contracts are reviewed, validated, and amended, including details of quality records kept, shall be documented.

3.5.3 Document and Data Control

Procedures defining how all documentation, including documents, software, and data, are validated, authorized, and controlled shall be documented.

3.5.4 Product Identification and Traceability

Procedures defining how product will be identified throughout the various processing stages and be traceable through unique identification of individual product or lots shall be documented.

3.5.5 Process Control

Plans and procedures identifying and defining how receiving, production, servicing, and installation processes are carried out and controlled shall be documented.

3.5.6 Inspection and Testing

Procedures defining how the products are to be inspected and tested, including identification of quality characteristics, associated acceptance criteria, and the information to be contained in resulting records shall be documented.

3.5.7 Control of Inspection, Measuring, and Test Equipment

Procedures defining how all inspection, measuring, and test equipment used in the inspection and testing of products are to be controlled, used, and maintained to provide valid results, including identification of characteristics being monitored, associated acceptance criteria, and the information to be contained in quality records, shall be documented.

3.5.8 Inspection and Test Status

Procedures defining how the inspection and test status of product is made known in the test facility environment shall be documented.

3.5.9 Control of Nonconformances

Procedures defining how nonconforming systems, processes, activities, and products are identified and controlled shall be documented.

3.5.10 Corrective and Preventive Action

Procedures defining how nonconformances detected during the course of the work or otherwise will be investigated, corrected, and prevented shall be documented.

3.5.11 Handling, Storage, Packaging, Preservation, and Delivery

Procedures defining how products are handled, stored, packaged, preserved, and delivery to ensure the on-going compliance of the products to legal and quality requirements shall be documented.

3.5.12 Quality Records

Procedures defining how records of work performed, including inspection forms and corrective action reports, are controlled and made accessible for review shall be documented.

3.5.13 Internal Quality Audits

Procedures defining how the quality of work is audited, including the frequency of audit and the acceptance criteria used, shall be documented.

3.5.14 Training

Procedures defining and describing the details of training necessary for personnel managing, performing, and verifying the quality of the work, including details of quality records kept, shall be documented.

4. Application-Specific System Requirements

4.1 General

4.1.1 This section defines and describes the application-specific requirements for inclusion in a quality system for the use of statistical methods in metrological control applications.

4.1.2 The organization shall address the requirements of this section, according to the activity type, within the quality system required in section 3.

4.2 Sampling Inspection

4.2.1 The organization shall develop and document procedures to meet the requirements of sampling inspection documents S-S-05 and S-S-06, as applicable.

4.2.2 The procedures required by clause 4.2.1 shall include, but are not necessarily limited to, such activities as:

(a) planning for the use of sampling inspection;

(b) qualification for sampling inspection;
(c) formation and management of lots;
(d) verification of lot homogeneity;
(e) scheduling lot formation and sampling (compliance sampling);
(f) determination of sampling type (attributes or variables);
(g) determination of inspection level under switching schemes (acceptance sampling);
(h) selection of the sample;
(i) sample removal (compliance sampling);
(j) accounting for sample units;
(k) handling and storage of sample units, both before and after inspection;
(l) preconditioning of sample units;
(m) testing of sample units;
(n) documentation of test results;
(o) analysis of test results;
(p) determination of lot acceptability;
(q) disposition of nonconforming lots or units;
(r) preservation of lot compliance during transportation and installation;
(s) corrective action investigations;
(t) facilitation of process and product audits;
(u) statistical quality records; and
(v) reporting of results and findings.

4.3 Product Auditing

4.3.1 The organization shall develop and document procedures to meet the requirements of product auditing document S-S-07.

4.3.2 The procedures required by clause 4.3.1 shall include, but are not necessarily limited to, such auditor-related activities as:

(a) planning of audit scope;
(b) determination of audit frequency;
(c) identification of independent auditor;
(d) scheduling of audits;
(e) conducting of audits;
(f) reporting of audit findings;
(g) evaluation of the adequacy of documented investigations and resulting corrective actions; and
(h) following up on corrective actions through audit.

4.3.3 The procedures required by clause 4.3.1 shall include, but are not necessarily limited to, such auditee-related activities as:

(a) facilitation of audit implementation;

(b) investigation of the root causes of nonconformances;
(c) disposition and containment of nonconforming products;
(d) evaluation of the magnitude and extent of discovered nonconformances;
(e) documentation of all details of the investigations and evaluations;
(f) development and documentation of corrective and preventive actions; and
(g) implementation of corrective and preventive actions.

SECTION 03

General Methods

Contents

1. Scope

1.1 General

This document specifies the requirements for the general methods involved in the administration of the various statistical techniques located throughout the document series S-S-XX: *Statistical Methods for Metrological Control*.

1.2 Applicability

The methods contained in this document are applicable when referenced by any other method, test, or plan laid out in the S-S-XX document series.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-02: *Statistical Methods for Metrological Control — Quality System Requirements.*

S-S-05: *Statistical Methods for Metrological Control — Acceptance Sampling Plans.*

S-S-06: *Statistical Methods for Metrological Control — Compliance Sampling Plans.*

1.4 Definitions

The definitions in document S-S-01 apply.

2. Rounding

2.1 Scope

This section specifies the requirements for rounding observations and functions of observations which are used in the calculation of statistical quantities and in statistical decision-making procedures.

2.2 Applicability

The requirements of this section are applicable for correcting situations where observations and their functions are reported to more figures than are required or justified for the purpose in view.

2.3 Rules for Rounding

2.3.1 To round a number to n significant figures, the following rules shall be followed:

(a) when the figure immediately to the right of the n^{th} figure is less than 5, the n^{th} figure shall be kept unchanged;

(b) when the figure immediately to the right of the n^{th} figure is greater than 5, the n^{th} figure shall be increased by 1;

(c) when the figure immediately to the right of the n^{th} figure is equal to 5, and

(i) there are no figures or only zeroes following this 5, the n^{th} figure shall be increased by 1 if odd or kept unchanged if even, or

(ii) there are any figures other than zero following this 5, the n^{th} figure shall be increased by 1, whether odd or even.

2.3.2 A number shall always be rounded off in one step to the number of figures that are to be recorded

2.4 Observations and Calculations

2.4.1 All observations shall be rounded to the appropriate number of significant figures prior to performing any further processing of them.

2.4.2 All intermediate and final calculations involving observations shall be performed to produce results containing at least six figures and any decision shall be based accordingly on these values.

2.5 Presentation of Results

2.5.1 Observations shall be presented using the number of significant figures indicated by clause 2.4.1.

2.5.2 Calculated quantities used in statistical decision making shall be presented using one more figure than the associated critical value is defined as possessing.

3. Random Sampling

3.1 Scope

3.1.1 This section specifies the requirements for the methods of random sampling without replacement.

3.1.2 These methods are applicable wherever a statistical method requires a random sample to be drawn from a finite population.

3.2 Prerequisites

Prior to the commencement of random sampling, the following requirements shall be met:

(a) the population shall be of finite size N and explicitly defined;

(b) all items in the population shall be available for selection;

(c) each item in the population shall be assigned a distinct number from 1 to N;

(d) the size of the sample n shall be defined; and

(e) a random process meeting the requirements of clause 3.3 or 3.4, as the case may be, shall be available for identifying the random sample.

3.3 Random Sampling by Tables

3.3.1 The random sampling by tables method involves the use of published random number or random digit tables where the numbers or digits presented are based on the uniform distribution over some range of values.

3.3.2 The random number or random digit tables intended for use in the sampling process shall be obtained from an authoritative source and shall be of sufficient capacity for the sampling application.

3.3.3 The coordinates of the initially selected value in the book of tables and the direction taken for selecting successive values shall be determined by a suitable auxiliary random process and recorded.

3.3.4 Each successive number (or collection of digits) in the decided direction shall be recorded as a member of the random sample unless the number duplicates one already chosen or exceeds the population size N.

3.3.5 The process shall be continued until exactly n different random numbers result.

3.3.6 The items in the population corresponding to the n different random numbers obtained above shall be considered as the random sample.

3.4 Pseudo-Random Sampling

3.4.1 The pseudo-random sampling method involves the use of an algorithm which simulates the

properties of a random process and automatically scales its output to produce a set of random numbers directly suitable for a given sampling application.

3.4.2 The algorithm shall be designed such that it:

(a) generates numbers according to the uniform distribution;

(b) generates numbers which are randomly distributed and uncorrelated at any lag between successively generated numbers;

(c) accepts the population size N and sample size n as input parameters;

(d) has a cycle length of at least 100 000;

(e) scales its output over the range of integers from 1 to N inclusive;

(f) is capable of being seeded manually;

(g) repeats the same sequence of numbers upon use of the same seed;

(h) outputs exactly n different numbers when invoked; and

(i) has provisions to facilitate verification of the above properties.

3.4.3 The input parameters to the algorithm shall be the population size N, the sample size n, and a seed value which is within the range of the algorithm and has been determined by a suitable auxiliary random process.

3.4.4 The seed and set of n different random numbers produced by the algorithm shall be recorded.

3.4.5 The items in the population corresponding to the n different random numbers obtained above shall be considered as the random sample.

4. Qualifications for Sampling Inspection

4.1 Scope

This section specifies the requirements for institution and resumption of sampling inspection for products.

4.2 Applicability

4.2.1 The requirements of this section shall apply to products which are identified in the Specifications as being eligible for acceptance sampling or compliance sampling.

4.2.2 The requirements of this section shall apply to products which are being qualified for the introduction of sampling inspection or being requalified for the resumption of sampling inspection following a decision for discontinuation.

4.3 Institution of Sampling Inspection

4.3.1 Acceptance Sampling. Sampling inspection may be instituted for a particular product type or category when all of the following criteria are satisfied:

(a) the owner of the product has developed and implemented, and is maintaining, a quality system in accordance with the requirements of document S-S-02;

(b) one or more complete lots of homogeneous product amounting to at least 500 units have been submitted for inspection;

(c) the percentage of nonconforming product discovered in the most recently consecutive quantity of homogeneous product submitted in accordance with item (b) above does not exceed 1.0% with respect to each of the product's quantitative characteristics and 1.0% with respect to all other quality characteristics; and

(d) no serious nonconforming units were discovered in the product submitted in accordance with item (b) above;

(e) the owner has developed and is capable of implementing all administrative procedures necessary for meeting the requirements of the acceptance sampling plans.

4.3.2 Compliance Sampling. Sampling inspection may be instituted for a particular product type or category when all of the following criteria are satisfied:

(a) the owner of the product has developed and implemented, and is maintaining, a quality system in accordance with the requirements of document S-S-02;

(b) one or more complete lots of homogeneous product amounting to at least 500 units have been submitted for inspection;

(c) the percentage of nonconforming product discovered in the most recently consecutive quantity of homogeneous product submitted in accordance with item (b) above with respect to the product's quantitative and qualitative characteristics is sufficiently less than the compliance sampling plan's LQL value in Measurement Canada's assessment to make sampling inspection feasible;

(d) no serious nonconforming units were discovered in the product submitted in accordance with item (b) above;

(e) the owner has developed and is capable of implementing all administrative procedures necessary for meeting the requirements of the compliance sampling plans.

4.4 Resumption of Sampling Inspection

4.4.1 Acceptance Sampling. Sampling inspection may be resumed for a particular product type or category when all of the following criteria are satisfied:

(a) the owner of the product provides documented evidence that appropriate corrective action has been implemented to prevent recurrence of the nonconformities or defects causing the discontinuation of sampling inspection;

(b) one or more complete lots of homogeneous product totalling at least 200 units have been submitted for inspection since the discontinuation of sampling inspection;

(c) the percentage of nonconforming product discovered in the most recently consecutive quantity of homogeneous product submitted in accordance with item (b) above does not exceed 1.0% with respect to each of the product's quantitative characteristics and 1.0% with respect to all other quality characteristics; and

(d) no serious nonconforming units were discovered in the product submitted in accordance with item (b) above.

4.4.2 Compliance Sampling. Sampling inspection may be resumed for a particular product type or category when the owner of the product provides documented evidence that appropriate corrective action has been implemented to prevent recurrence of the nonconformances causing the discontinuation of sampling inspection.

SECTION 04

STATISTICAL TESTS

Contents

1. Scope

1.1 General

This document specifies the requirements for various statistical tests involved in the administration of the statistical techniques located throughout the document series S-S-XX: *Statistical Methods for Metrological Control.*

1.2 Applicability

The statistical tests contained in this document are applicable when referenced by any other method,

test, or plan laid out in the S-S-XX document series.

1.3 Referenced Documents

The following document is required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

1.4 Definitions

The definitions in document S-S-01 apply.

2. Normality Tests

2.1 Scope

This section specifies the requirements for determining whether a set of observations is distributed according to a normal distribution.

2.2 Test Statistics

2.2.1 Skewness. The estimate of the population skewness shall be computed from the following equation:

$$g_1 = \frac{n \sum_{i=1}^{n} (x_i - \bar{x})^3}{(n-1)(n-2)s^3}$$

2.2.2 Kurtosis. The estimate of the population kurtosis shall be computed from the following equation:

$$g_2 = \frac{n(n-1)\sum_{i=1}^{n} (x_i - \bar{x})^4 - 3\frac{(n-1)}{n}\left[\sum_{i=1}^{n} (x_i - \bar{x})^2\right]^2}{(n-1)(n-2)(n-3)s^4}$$

2.3 Acceptance Criteria

The set of observations shall be considered to be normally distributed if the following inequalities are

satisfied simultaneously:

(a) $\bullet g_1 \bullet \bullet 1.96\sqrt{\frac{6n(n\bullet 1)}{(n\bullet 2)(n\bullet 1)(n\bullet 3)}}$; and

(b) $\bullet g_2 \bullet \bullet 1.96\sqrt{\frac{24n(n\bullet 1)^2}{(n\bullet 3)(n\bullet 2)(n\bullet 3)(n\bullet 5)}}$.

3. Comparison of Two Variances

3.1 Scope

This section specifies a method for comparing the variances of two normal populations to determine if they are equal.

3.2 Test Statistic

The test statistic F shall be computed from the following equation:

$$F \bullet \frac{s_1^2}{s_2^2}$$

3.3 Acceptance Criteria

The variances of the two populations shall be considered equal if either of the two following inequalities are satisfied:

(a) $F \bullet \frac{1}{F_{1\bullet \alpha/2}(\nu_2, \nu_1)}$; or

(b) $F \bullet F_{1\bullet \alpha/2}(\nu_1, \nu_2)$,

where á is the significance level

4. Comparison of Two Means (Equal Variances)

4.1 Scope

This section specifies a method for comparing the means of two normal populations to determine if they are equal when both variances are unknown but assumed to be equal.

4.2 Test Statistic

The test statistic t shall be computed from the following equation:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

where:

$$s_p = \sqrt{\frac{\sum_{i=1}^{n_1} (x_{1i} - \bar{x}_1)^2 + \sum_{i=1}^{n_2} (x_{2i} - \bar{x}_2)^2}{n_1 + n_2 - 2}}$$

4.3 Acceptance Criteria

The means of the two populations shall be considered equal if the following inequality is satisfied:

$$t \le t_{1-\alpha/2}(v)$$

where:

$$v = n_1 + n_2 - 2$$

and á is the significance level

5. Comparison of Two Means (Unequal Variances)

5.1 Scope

This section specifies a method for comparing the means of two normal populations to determine if they are equal when both variances are unknown and assumed to be unequal.

5.2 Test Statistic

The test statistic t shall be computed from the following equation:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

5.3 Acceptance Criteria

The means of the two populations shall be considered equal if the following inequality is satisfied:

$$t \le t_{1-\alpha/2}(v)$$

where:

$$v = \frac{\left[\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right]^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

and α is the significance level

6. Comparison of Means and Variances

6.1 Scope

This section specifies a method for simultaneously comparing the means and variances for variables X_1 and X_2 to determine if they are equal where X_1 and X_2 are distributed bivariate normal.

6.2 Test Statistic

The test statistic F shall be computed from the following equation:

$$F = \frac{(n-2)\, SS_m}{2\left(\sum_{i=1}^{n} x_{Di}^2 - SS_m\right)}$$

where:

$$SS_m = \frac{\left(\sum_{i=1}^{n} x_{Di}\right)^2}{n} - \frac{\left(n \sum_{i=1}^{n} x_{Si} x_{Di} - \sum_{i=1}^{n} x_{Si} \sum_{i=1}^{n} x_{Di}\right)^2}{n \sum_{i=1}^{n} x_{Si}^2 - \left(\sum_{i=1}^{n} x_{Si}\right)^2}$$

$$x_{Di} \bullet x_{1i} \bullet x_{2i}$$

$$x_{Si} \bullet x_{1i} \bullet x_{2i}$$

6.3 Acceptance Criteria

The means and variances of variables X_1 and X_2 shall be considered equal if the following inequality is satisfied:

$$F \bullet F_{1 \bullet \alpha}(2, n \bullet 2)$$

where á is the significance level

A. *t* Tables

ν	$t_{0.95}$	$t_{0.975}$	ν	$t_{0.95}$	$t_{0.975}$
1	6.313752	12.70620	31	1.695519	2.039513
2	2.919986	4.302653	32	1.693889	2.036933
3	2.353363	3.182446	33	1.692360	2.034515
4	2.131847	2.776445	34	1.690924	2.032245
5	2.015048	2.570582	35	1.689572	2.030108
6	1.943180	2.446912	36	1.688298	2.028094
7	1.894579	2.364624	37	1.687094	2.026192
8	1.859548	2.306004	38	1.685954	2.024394
9	1.833113	2.262157	39	1.684875	2.022691
10	1.812461	2.228139	40	1.683851	2.021075
11	1.795885	2.200985	41	1.682878	2.019541
12	1.782288	2.178813	42	1.681952	2.018082
13	1.770933	2.160369	43	1.681071	2.016692
14	1.761310	2.144787	44	1.680230	2.015368
15	1.753050	2.131450	45	1.679427	2.014103
16	1.745884	2.119905	46	1.678660	2.012896
17	1.739607	2.109816	47	1.677927	2.011741
18	1.734064	2.100922	48	1.677224	2.010635
19	1.729133	2.093024	49	1.676551	2.009575
20	1.724718	2.085963	50	1.675905	2.008559
21	1.720743	2.079614	51	1.675285	2.007584
22	1.717144	2.073873	52	1.674689	2.006647
23	1.713872	2.068658	53	1.674116	2.005746
24	1.710882	2.063899	54	1.673565	2.004879
25	1.708141	2.059539	55	1.673034	2.004045
26	1.705618	2.055529	56	1.672522	2.003241
27	1.703288	2.051831	57	1.672029	2.002465
28	1.701131	2.048407	58	1.671553	2.001717
29	1.699127	2.045230	59	1.671093	2.000995
30	1.697261	2.042272	60	1.670649	2.000298

ν	$t_{0.95}$	$t_{0.975}$	ν	$t_{0.95}$	$t_{0.975}$
61	1.670219	1.999624	91	1.661771	1.986377
62	1.669804	1.998972	92	1.661585	1.986086
63	1.669402	1.998341	93	1.661404	1.985802
64	1.669013	1.997730	94	1.661226	1.985523
65	1.668636	1.997138	95	1.661052	1.985251
66	1.668271	1.996564	96	1.660881	1.984984
67	1.667916	1.996008	97	1.660715	1.984723
68	1.667572	1.995469	98	1.660551	1.984467
69	1.667239	1.994945	99	1.660391	1.984217
70	1.666914	1.994437	100	1.660234	1.983972
71	1.666600	1.993943	101	1.660081	1.983731
72	1.666294	1.993464	102	1.659930	1.983495
73	1.665996	1.992997	103	1.659782	1.983264
74	1.665707	1.992543	104	1.659637	1.983038
75	1.665425	1.992102	105	1.659495	1.982815
76	1.665151	1.991673	106	1.659356	1.982597
77	1.664885	1.991254	107	1.659219	1.982383
78	1.664625	1.990847	108	1.659085	1.982173
79	1.664371	1.990450	109	1.658953	1.981967
80	1.664125	1.990063	110	1.658824	1.981765
81	1.663884	1.989686	111	1.658697	1.981567
82	1.663649	1.989319	112	1.658573	1.981372
83	1.663420	1.988960	113	1.658450	1.981180
84	1.663197	1.988610	114	1.658330	1.980992
85	1.662978	1.988268	115	1.658212	1.980808
86	1.662765	1.987934	116	1.658096	1.980626
87	1.662557	1.987608	117	1.657982	1.980448
88	1.662354	1.987290	118	1.657870	1.980272
89	1.662155	1.986979	119	1.657759	1.980100
90	1.661961	1.986675	120	1.657651	1.979930
			•	1.644854	1.959964

B. $F_{.95}$ Tables

B-1

v_2	v_1					
	1	2	3	4	5	6
1	161.4476	199.5000	215.7073	224.5832	230.1619	233.9860
2	18.51282	19.00000	19.16429	19.24679	19.29641	19.32953
3	10.12796	9.552094	9.276628	9.117182	9.013455	8.940645
4	7.708647	6.944272	6.591382	6.388233	6.256057	6.163132
5	6.607891	5.786135	5.409451	5.192168	5.050329	4.950288
6	5.987378	5.143253	4.757063	4.533677	4.387374	4.283866
7	5.591448	4.737414	4.346831	4.120312	3.971523	3.865969
8	5.317655	4.458970	4.066181	3.837853	3.687499	3.580580
9	5.117355	4.256495	3.862548	3.633089	3.481659	3.373754
10	4.964603	4.102821	3.708265	3.478050	3.325835	3.217175
11	4.844336	3.982298	3.587434	3.356690	3.203874	3.094613
12	4.747225	3.885294	3.490295	3.259167	3.105875	2.996120
13	4.667193	3.805565	3.410534	3.179117	3.025438	2.915269
14	4.600110	3.738892	3.343889	3.112250	2.958249	2.847726
15	4.543077	3.682320	3.287382	3.055568	2.901295	2.790465
16	4.493998	3.633723	3.238872	3.006917	2.852409	2.741311
17	4.451322	3.591531	3.196777	2.964708	2.809996	2.698660
18	4.413873	3.554557	3.159908	2.927744	2.772853	2.661305
19	4.380750	3.521893	3.127350	2.895107	2.740058	2.628318
20	4.351244	3.492828	3.098391	2.866081	2.710890	2.598978
21	4.324794	3.466800	3.072467	2.840100	2.684781	2.572712
22	4.300950	3.443357	3.049125	2.816708	2.661274	2.549061
23	4.279344	3.422132	3.027998	2.795539	2.639999	2.527655
24	4.259677	3.402826	3.008787	2.776289	2.620654	2.508189
25	4.241699	3.385190	2.991241	2.758710	2.602987	2.490410
26	4.225201	3.369016	2.975154	2.742594	2.586790	2.474109
27	4.210008	3.354131	2.960351	2.727765	2.571886	2.459108
28	4.195972	3.340386	2.946685	2.714076	2.558128	2.445259
29	4.182964	3.327654	2.934030	2.701399	2.545386	2.432434
30	4.170877	3.315830	2.922277	2.689628	2.533555	2.420523

B-2

v_2	v_1					
	7	8	9	10	11	12
1	236.7684	238.8827	240.5433	241.8817	242.9835	243.9060
2	19.35322	19.37099	19.38483	19.39590	19.40496	19.41251
3	8.886743	8.845238	8.812300	8.785525	8.763333	8.744641
4	6.094211	6.041044	5.998779	5.964371	5.935813	5.911729
5	4.875872	4.818320	4.772466	4.735063	4.703967	4.677704
6	4.206658	4.146804	4.099016	4.059963	4.027442	3.999935
7	3.787044	3.725725	3.676675	3.636523	3.603037	3.574676
8	3.500464	3.438101	3.388130	3.347163	3.312951	3.283939
9	3.292746	3.229583	3.178893	3.137280	3.102485	3.072947
10	3.135465	3.071658	3.020383	2.978237	2.942957	2.912977
11	3.012330	2.947990	2.896223	2.853625	2.817930	2.787569
12	2.913358	2.848565	2.796375	2.753387	2.717331	2.686637
13	2.832098	2.766913	2.714356	2.671024	2.634650	2.603661
14	2.764199	2.698672	2.645791	2.602155	2.565497	2.534243
15	2.706627	2.640797	2.587626	2.543719	2.506806	2.475313
16	2.657197	2.591096	2.537667	2.493513	2.456369	2.424660
17	2.614299	2.547955	2.494291	2.449916	2.412561	2.380654
18	2.576722	2.510158	2.456281	2.411702	2.374156	2.342067
19	2.543534	2.476770	2.422699	2.377934	2.340210	2.307954
20	2.514011	2.447064	2.392814	2.347878	2.309991	2.277581
21	2.487578	2.420462	2.366048	2.320953	2.282916	2.250362
22	2.463774	2.396503	2.341937	2.296696	2.258518	2.225831
23	2.442226	2.374812	2.320105	2.274728	2.236419	2.203607
24	2.422629	2.355081	2.300244	2.254739	2.216309	2.183380
25	2.404728	2.337057	2.282097	2.236474	2.197929	2.164891
26	2.388314	2.320527	2.265453	2.219718	2.181067	2.147926
27	2.373208	2.305313	2.250131	2.204292	2.165540	2.132303
28	2.359260	2.291264	2.235982	2.190044	2.151197	2.117869
29	2.346342	2.278251	2.222874	2.176844	2.137908	2.104493
30	2.334344	2.266163	2.210697	2.164580	2.125559	2.092063

B-3

v_2	v_1					
	13	14	15	16	17	18
1	244.6898	245.3640	245.9499	246.4639	246.9184	247.3232
2	19.41890	19.42438	19.42914	19.43329	19.43696	19.44022
3	8.728681	8.714896	8.702870	8.692286	8.682900	8.674519
4	5.891144	5.873346	5.857805	5.844117	5.831970	5.821116
5	4.655225	4.635768	4.618759	4.603764	4.590444	4.578534
6	3.976363	3.955934	3.938058	3.922283	3.908259	3.895709
7	3.550343	3.529231	3.510740	3.494408	3.479877	3.466863
8	3.259019	3.237378	3.218406	3.201634	3.186701	3.173317
9	3.047549	3.025473	3.006102	2.988966	2.973696	2.960003
10	2.887175	2.864728	2.845017	2.827566	2.812007	2.798045
11	2.761417	2.738648	2.718640	2.700914	2.685100	2.670901
12	2.660177	2.637124	2.616851	2.598881	2.582839	2.568428
13	2.576927	2.553619	2.533110	2.514920	2.498672	2.484069
14	2.507263	2.483726	2.463003	2.444613	2.428179	2.413401
15	2.448110	2.424364	2.403447	2.384875	2.368270	2.353332
16	2.397254	2.373318	2.352223	2.333484	2.316722	2.301636
17	2.353063	2.328952	2.307693	2.288800	2.271893	2.256671
18	2.314304	2.290033	2.268622	2.249587	2.232546	2.217197
19	2.280034	2.255614	2.234063	2.214895	2.197729	2.182263
20	2.249514	2.224956	2.203274	2.183983	2.166701	2.151124
21	2.222160	2.197473	2.175670	2.156263	2.138872	2.123193
22	2.197502	2.172695	2.150778	2.131264	2.113771	2.097994
23	2.175160	2.150240	2.128217	2.108602	2.091013	2.075145
24	2.154822	2.129797	2.107673	2.087963	2.070284	2.054331
25	2.136229	2.111105	2.088887	2.069088	2.051323	2.035289
26	2.119166	2.093949	2.071642	2.051758	2.033913	2.017802
27	2.103450	2.078145	2.055755	2.035790	2.017869	2.001686
28	2.088929	2.063541	2.041071	2.021031	2.003037	1.986785
29	2.075471	2.050004	2.027458	2.007346	1.989284	1.972966
30	2.062963	2.037420	2.014804	1.994624	1.976496	1.960116

B-4

v_2	v_1					
	19	20	21	22	23	24
1	247.6861	248.0131	248.3094	248.5791	248.8256	249.0518
2	19.44314	19.44577	19.44815	19.45031	19.45228	19.45409
3	8.666990	8.660190	8.654017	8.648389	8.643236	8.638501
4	5.811359	5.802542	5.794534	5.787230	5.780539	5.774389
5	4.567820	4.558131	4.549327	4.541291	4.533926	4.527153
6	3.884412	3.874189	3.864893	3.856403	3.848619	3.841457
7	3.455140	3.444525	3.434867	3.426042	3.417947	3.410494
8	3.161254	3.150324	3.140374	3.131277	3.122929	3.115240
9	2.947652	2.936455	2.926257	2.916930	2.908365	2.900474
10	2.785445	2.774016	2.763602	2.754072	2.745317	2.737248
11	2.658080	2.646445	2.635838	2.626127	2.617203	2.608974
12	2.555409	2.543588	2.532807	2.522933	2.513856	2.505482
13	2.470871	2.458882	2.447942	2.437920	2.428702	2.420196
14	2.400039	2.387896	2.376812	2.366653	2.357306	2.348678
15	2.339819	2.327535	2.316317	2.306032	2.296567	2.287826
16	2.287985	2.275570	2.264229	2.253827	2.244251	2.235405
17	2.242891	2.230354	2.218899	2.208388	2.198709	2.189766
18	2.203297	2.190648	2.179085	2.168474	2.158699	2.149665
19	2.168252	2.155497	2.143834	2.133127	2.123263	2.114143
20	2.137009	2.124155	2.112399	2.101603	2.091654	2.082454
21	2.108979	2.096033	2.084189	2.073309	2.063280	2.054004
22	2.083689	2.070656	2.058728	2.047770	2.037666	2.028319
23	2.060754	2.047638	2.035633	2.024600	2.014425	2.005009
24	2.039858	2.026664	2.014585	2.003482	1.993239	1.983760
25	2.020738	2.007471	1.995322	1.984152	1.973846	1.964306
26	2.003178	1.989842	1.977626	1.966393	1.956026	1.946428
27	1.986993	1.973590	1.961312	1.950018	1.939594	1.929940
28	1.972027	1.958561	1.946222	1.934871	1.924392	1.914686
29	1.958146	1.944620	1.932224	1.920819	1.910287	1.900531
30	1.945236	1.931653	1.919203	1.907745	1.897164	1.887360

ν_2	ν_1					
	25	26	27	28	29	30
1	249.2601	249.4525	249.6309	249.7966	249.9510	250.0951
2	19.45575	19.45729	19.45871	19.46003	19.46126	19.46241
3	8.634135	8.630096	8.626350	8.622865	8.619614	8.616576
4	5.768715	5.763466	5.758594	5.754060	5.749831	5.745877
5	4.520902	4.515116	4.509744	4.504743	4.500077	4.495712
6	3.834844	3.828720	3.823032	3.817735	3.812791	3.808164
7	3.403611	3.397233	3.391307	3.385787	3.380632	3.375808
8	3.108134	3.101549	3.095428	3.089724	3.084395	3.079406
9	2.893178	2.886414	2.880125	2.874262	2.868783	2.863652
10	2.729785	2.722863	2.716424	2.710420	2.704808	2.699551
11	2.601360	2.594296	2.587724	2.581593	2.575861	2.570489
12	2.497732	2.490539	2.483844	2.477597	2.471755	2.466279
13	2.412321	2.405009	2.398202	2.391849	2.385906	2.380334
14	2.340688	2.333267	2.326357	2.319905	2.313868	2.308207
15	2.279729	2.272207	2.265201	2.258658	2.252534	2.246789
16	2.227209	2.219593	2.212497	2.205868	2.199663	2.193841
17	2.181478	2.173773	2.166593	2.159885	2.153603	2.147708
18	2.141289	2.133502	2.126243	2.119460	2.113107	2.107143
19	2.105686	2.097821	2.090489	2.083635	2.077214	2.071186
20	2.073920	2.065983	2.058580	2.051659	2.045175	2.039086
21	2.045398	2.037392	2.029923	2.022940	2.016395	2.010248
22	2.019644	2.011572	2.004042	1.996998	1.990396	1.984195
23	1.996271	1.988137	1.980547	1.973447	1.966791	1.960537
24	1.974959	1.966767	1.959121	1.951967	1.945259	1.938957
25	1.955447	1.947199	1.939500	1.932295	1.925538	1.919188
26	1.937514	1.929213	1.921462	1.914209	1.907405	1.901010
27	1.920974	1.912622	1.904823	1.897523	1.890674	1.884236
28	1.905669	1.897269	1.889424	1.882079	1.875188	1.868709
29	1.891466	1.883020	1.875131	1.867744	1.860811	1.854293
30	1.878249	1.869759	1.861827	1.854399	1.847428	1.840872

C. $F_{.975}$ Tables

C-1

ν_2	ν_1					
	1	2	3	4	5	6
1	647.7890	799.5000	864.1630	899.5833	921.8479	937.1111
2	38.50633	39.00000	39.16549	39.24842	39.29823	39.33146
3	17.44344	16.04411	15.43918	15.10098	14.88482	14.73472
4	12.21786	10.64911	9.979199	9.604530	9.364471	9.197311
5	10.00698	8.433621	7.763589	7.387886	7.146382	6.977702
6	8.813101	7.259856	6.598799	6.227161	5.987565	5.819757
7	8.072669	6.541520	5.889819	5.522594	5.285237	5.118597
8	7.570882	6.059467	5.415962	5.052632	4.817276	4.651696
9	7.209283	5.714705	5.078119	4.718078	4.484411	4.319722
10	6.936728	5.456396	4.825621	4.468342	4.236086	4.072131
11	6.724130	5.255889	4.630025	4.275072	4.043998	3.880651
12	6.553769	5.095867	4.474185	4.121209	3.891134	3.728292
13	6.414254	4.965266	4.347178	3.995898	3.766674	3.604256
14	6.297939	4.856698	4.241728	3.891914	3.663423	3.501365
15	6.199501	4.765048	4.152804	3.804271	3.576415	3.414665
16	6.115127	4.686665	4.076823	3.729417	3.502116	3.340631
17	6.042013	4.618874	4.011163	3.664754	3.437944	3.276689
18	5.978052	4.559672	3.953863	3.608344	3.381968	3.220915
19	5.921631	4.507528	3.903428	3.558706	3.332718	3.171844
20	5.871494	4.461255	3.858699	3.514695	3.289056	3.128340
21	5.826648	4.419918	3.818761	3.475408	3.250084	3.089509
22	5.786299	4.382768	3.782886	3.440126	3.215087	3.054639
23	5.749805	4.349202	3.750486	3.408268	3.183488	3.023154
24	5.716639	4.318726	3.721080	3.379359	3.154816	2.994586
25	5.686366	4.290932	3.694273	3.353009	3.128684	2.968549
26	5.658624	4.265483	3.669736	3.328894	3.104770	2.944720
27	5.633109	4.242094	3.647192	3.306741	3.082802	2.922831
28	5.609564	4.220525	3.626408	3.286321	3.062554	2.902655
29	5.587768	4.200572	3.607187	3.267438	3.043830	2.883998
30	5.567535	4.182061	3.589359	3.249925	3.026466	2.866696

C-2

v_2	v_1					
	7	8	9	10	11	12
1	948.2169	956.6562	963.2846	968.6274	973.0252	976.7079
2	39.35521	39.37302	39.38688	39.39797	39.40705	39.41462
3	14.62440	14.53989	14.47308	14.41894	14.37418	14.33655
4	9.074141	8.979580	8.904682	8.843881	8.793535	8.751159
5	6.853076	6.757172	6.681054	6.619154	6.567819	6.524549
6	5.695470	5.599623	5.523407	5.461324	5.409761	5.366244
7	4.994909	4.899341	4.823217	4.761116	4.709470	4.665830
8	4.528562	4.433260	4.357233	4.295127	4.243413	4.199667
9	4.197047	4.101956	4.025994	3.963865	3.912074	3.868220
10	3.949824	3.854891	3.778963	3.716792	3.664914	3.620945
11	3.758638	3.663819	3.587899	3.525672	3.473699	3.429613
12	3.606515	3.511777	3.435846	3.373553	3.321481	3.277277
13	3.482669	3.387987	3.312032	3.249668	3.197496	3.153175
14	3.379933	3.285288	3.209300	3.146861	3.094590	3.050155
15	3.293360	3.198738	3.122712	3.060197	3.007828	2.963282
16	3.219431	3.124822	3.048753	2.986163	2.933699	2.889048
17	3.155577	3.060973	2.984859	2.922195	2.869639	2.824886
18	3.099877	3.005271	2.929112	2.866376	2.813732	2.768881
19	3.050868	2.956257	2.880052	2.817245	2.764517	2.719574
20	3.007416	2.912797	2.836546	2.773671	2.720862	2.675831
21	2.968630	2.873999	2.797704	2.734764	2.681877	2.636762
22	2.933799	2.839155	2.762815	2.699813	2.646852	2.601657
23	2.902347	2.807689	2.731307	2.668244	2.615213	2.569941
24	2.873808	2.779135	2.702711	2.639590	2.586492	2.541148
25	2.847795	2.753106	2.676642	2.613466	2.560304	2.514890
26	2.823988	2.729283	2.652780	2.589551	2.536328	2.490848
27	2.802118	2.707396	2.630856	2.567576	2.514294	2.468752
28	2.781959	2.687220	2.610643	2.547315	2.493978	2.448375
29	2.763317	2.668562	2.591950	2.528575	2.475184	2.429524
30	2.746027	2.651256	2.574610	2.511191	2.457749	2.412034

C-3

ν_2	ν_1					
	13	14	15	16	17	18
1	979.8368	982.5278	984.8668	986.9187	988.7331	990.3490
2	39.42102	39.42650	39.43126	39.43542	39.43910	39.44236
3	14.30448	14.27682	14.25271	14.23152	14.21274	14.19599
4	8.714996	8.683773	8.656541	8.632581	8.611335	8.592368
5	6.487580	6.455625	6.427728	6.403161	6.381360	6.361883
6	5.329020	5.296811	5.268667	5.243860	5.221830	5.202135
7	4.628460	4.596094	4.567787	4.542818	4.520627	4.500773
8	4.162170	4.129665	4.101213	4.076096	4.053759	4.033762
9	3.830596	3.797952	3.769357	3.744097	3.721617	3.701481
10	3.583191	3.550410	3.521673	3.496271	3.473652	3.453379
11	3.391728	3.358810	3.329935	3.304395	3.281639	3.261234
12	3.239263	3.206212	3.177201	3.151527	3.128640	3.108106
13	3.115036	3.081854	3.052713	3.026910	3.003896	2.983239
14	3.011894	2.978588	2.949321	2.923394	2.900258	2.879483
15	2.924904	2.891479	2.862093	2.836047	2.812796	2.791908
16	2.850558	2.817018	2.787518	2.761359	2.737998	2.717003
17	2.786289	2.752641	2.723032	2.696766	2.673300	2.652204
18	2.730183	2.696431	2.666719	2.640351	2.616786	2.595592
19	2.680778	2.646928	2.617118	2.590654	2.566993	2.545708
20	2.636943	2.603000	2.573096	2.546540	2.522790	2.501417
21	2.597787	2.563754	2.533762	2.507119	2.483283	2.461827
22	2.562599	2.528482	2.498405	2.471679	2.447762	2.426226
23	2.530804	2.496607	2.466451	2.439645	2.415651	2.394039
24	2.501935	2.467662	2.437429	2.410548	2.386480	2.364797
25	2.475606	2.441259	2.410954	2.384002	2.359863	2.338111
26	2.451495	2.417079	2.386705	2.359684	2.335479	2.313661
27	2.429334	2.394852	2.364412	2.337326	2.313056	2.291176
28	2.408895	2.374350	2.343847	2.316698	2.292368	2.270428
29	2.389984	2.355379	2.324816	2.297608	2.273219	2.251222
30	2.372437	2.337775	2.307154	2.279889	2.255444	2.233392

C-4

v_2	v_1					
	19	20	21	22	23	24
1	991.7973	993.1028	994.2856	995.3622	996.3462	997.2492
2	39.44528	39.44791	39.45029	39.45245	39.45443	39.45624
3	14.18096	14.16738	14.15507	14.14385	14.13358	14.12415
4	8.575331	8.559943	8.545977	8.533243	8.521585	8.510873
5	6.344376	6.328555	6.314187	6.301080	6.289076	6.278040
6	5.184420	5.168401	5.153845	5.140561	5.128388	5.117192
7	4.482906	4.466740	4.452042	4.438622	4.426319	4.414999
8	4.015754	3.999453	3.984625	3.971080	3.958656	3.947220
9	3.683338	3.666906	3.651951	3.638284	3.625743	3.614196
10	3.435104	3.418544	3.403466	3.389680	3.377026	3.365369
11	3.242830	3.226145	3.210948	3.197046	3.184282	3.172519
12	3.089577	3.072773	3.057460	3.043448	3.030576	3.018711
13	2.964591	2.947671	2.932247	2.918128	2.905155	2.893191
14	2.860722	2.843691	2.828161	2.813941	2.800869	2.788811
15	2.773037	2.755902	2.740271	2.725953	2.712787	2.700640
16	2.698029	2.680793	2.665065	2.650654	2.637399	2.625166
17	2.633130	2.615799	2.599979	2.585480	2.572140	2.559824
18	2.576425	2.559003	2.543096	2.528512	2.515090	2.502697
19	2.526451	2.508943	2.492952	2.478287	2.464789	2.452321
20	2.482075	2.464484	2.448414	2.433673	2.420101	2.407562
21	2.442404	2.424735	2.408589	2.393775	2.380133	2.367526
22	2.406726	2.388983	2.372765	2.357881	2.344171	2.331500
23	2.374466	2.356652	2.340365	2.325415	2.311641	2.298907
24	2.345154	2.327271	2.310919	2.295906	2.282070	2.269277
25	2.318402	2.300455	2.284040	2.268966	2.255071	2.242222
26	2.293888	2.275879	2.259404	2.244272	2.230322	2.217418
27	2.271342	2.253274	2.236742	2.221554	2.207550	2.194595
28	2.250535	2.232411	2.215824	2.200583	2.186528	2.173522
29	2.231274	2.213095	2.196455	2.181164	2.167059	2.154006
30	2.213391	2.195160	2.178470	2.163130	2.148978	2.135879

v_2	v_1					
	25	26	27	28	29	30
1	998.0808	998.8490	999.5609	1000.000	1000.000	1000.000
2	39.45790	39.45944	39.46086	39.46219	39.46342	39.46457
3	14.11545	14.10741	14.09996	14.09303	14.08656	14.08052
4	8.500996	8.491860	8.483384	8.475500	8.468147	8.461274
5	6.267860	6.258440	6.249698	6.241564	6.233975	6.226879
6	5.106861	5.097297	5.088418	5.080153	5.072441	5.065227
7	4.404548	4.394871	4.385883	4.377514	4.369702	4.362393
8	3.936659	3.926875	3.917786	3.909320	3.901414	3.894016
9	3.603527	3.593640	3.584452	3.575891	3.567896	3.560410
10	3.354595	3.344608	3.335324	3.326671	3.318587	3.311017
11	3.161644	3.151559	3.142182	3.133439	3.125269	3.117617
12	3.007738	2 997560	2.988092	2.979263	2.971010	2.963278
13	2.882124	2.871855	2.862301	2.853389	2.845056	2.837247
14	2.777654	2.767298	2.757661	2.748669	2.740259	2.732377
15	2.689396	2.678957	2.669240	2.660171	2.651688	2.643735
16	2.613839	2.603321	2.593528	2.584387	2.575833	2.567813
17	2.548419	2.537825	2.527959	2.518748	2.510127	2.502042
18	2.491216	2.480551	2.470615	2.461336	2.452651	2.444504
19	2.440769	2.430034	2.420032	2.410689	2.401943	2.393736
20	2.395941	2.385140	2.375075	2.365671	2.356866	2.348602
21	2.355839	2.344976	2.334850	2.325388	2.316526	2.308208
22	2.319751	2.308827	2.298643	2.289125	2.280209	2.271840
23	2.287099	2.276117	2.265878	2.256306	2.247339	2.238919
24	2.257412	2.246375	2.236082	2.226460	2.217443	2.208976
25	2.230302	2.219213	2.208869	2.199197	2.190133	2.181619
26	2.205446	2.194306	2.183913	2.174194	2.165084	2.156527
27	2.182572	2.171384	2.160944	2.151180	2.142026	2.133427
28	2.161452	2.150217	2.139732	2.129924	2.120728	2.112088
29	2.141889	2.130610	2.120082	2.110232	2.100996	2.092317
30	2.123718	2.112395	2.101826	2.091936	2.082661	2.073944

SECTION 05

Acceptance Sampling Plans

Contents

1. Scope

1.1 General

1.1.1 This document specifies the requirements for the evaluation of products on a lot-by-lot basis through the use of acceptance sampling methods.

1.1.2 The object of the sampling plans laid out in this document is to ensure that lots of acceptable quality have a high probability of acceptance and that the probability of rejection of inferior lots is as high as possible.

1.2 Applicability

1.2.1 The sampling plans in this document are designed for assessing the quality of a continuous series of lots of product which have been produced or processed under the controlled conditions of a quality system.

1.2.2 The sampling-by-attributes plans are applicable for assessing the quality of product characteristics which are measurable on a discrete or continuous scale, regardless of their distributional form.

1.2.3 The sampling-by-variables plans are applicable for assessing the quality of product characteristics which are measurable on a continuous scale and are distributed according to a normal distribution.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-02: *Statistical Methods for Metrological Control — Quality System Requirements.*

S-S-03: *Statistical Methods for Metrological Control — General Methods.*

S-S-04: *Statistical Methods for Metrological Control — Statistical Tests*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

1.5.1 The organization producing product intended for evaluation by acceptance sampling methods shall be responsible for:

(a) documenting, implementing, and maintaining a quality system in accordance with document S-S-02 which produces and preserves the integrity of products at a quality level adequate for acceptance sampling inspection;

(b) taking appropriate corrective action on all nonconformances reported by the inspector or auditor, or otherwise discovered; and

(c) maintaining all records necessary to support the continuation of the use of acceptance sampling and making these records available for review on request.

1.5.2 The organization wishing to evaluate product by acceptance sampling methods shall be responsible for:

(a) documenting, implementing, and maintaining a quality system in accordance with document S-S-02 to ensure the requirements of this document are met;

(b) taking appropriate corrective action on all nonconformances reported or otherwise discovered; and

(c) maintaining all records required by this document and making these records available for review on request

2. General Requirements

2.1 Scope

2.1.1 This section specifies the general requirements for the evaluation of product by acceptance sampling methods.

2.1.2 The requirements in this section apply in addition to those of other sections of this document.

2.2 Prerequisites to Sampling Inspection

Before acceptance sampling methods may be used to evaluate a product, all of the following conditions shall be met:

(a) the organization wishing to use acceptance sampling methods shall develop, implement, obtain authorization of, and maintain a quality system in accordance with document S-S-02;

(b) the product type shall be one of those identified in Part 2 of this document as being eligible for evaluation by acceptance sampling;

(c) the subject product shall be verified as having been produced under the controlled conditions of the quality system; and

(d) the production quality of the product shall meet the criteria specified in section 4 of document S-S-03.

2.3 Lot Formation

2.3.1 A lot shall be formed only from product specifically identified in Part 2 of this document as being eligible for evaluation by acceptance sampling methods.

2.3.2 The lot shall be formed only from product that is available for sample selection.

2.3.3 The composition of the lot shall comply with the criteria for lot homogeneity as defined in the applicable section in Part 2 of this document

2.3.4 All units of product in the lot shall be individually identified on a list by the owner and arranged in ascending order based on product identification numbers.

2.4 Sample Selection

2.4.1 The sample shall be chosen from the lot listing by the inspector.

2.4.2 The size of the sample to be selected shall be determined in accordance with the criteria specified for the particular type of sampling being used.

2.4.3 The sample shall be selected from the lot based on either the random sampling method using authorized tables of uniformly-distributed random numbers or the pseudo-random sampling method using an authorized computer algorithm for pseudo-random number generation.

2.4.4 Where uniformly-distributed random number tables are used, the coordinates of the initially selected value and the direction taken for selecting successive values shall be recorded.

2.4.5 Where pseudo-random sampling is used, the value of the seed shall be recorded.

2.5 Product Inspection and Quality Characteristics

2.5.1 Each sample unit of product shall be examined for conformance to all pertinent acceptance requirements, according to the type of product.

2.5.2 Each sample unit of product shall be prepared for test and inspected in accordance with product-specific documented procedures which have been authorized by Measurement Canada.

2.5.3 All sample units shall be inspected under identical conditions, within as short a time period as is practicable to achieve valid inspection results.

2.5.4 The identification of each sample unit and the test results for each quality characteristic examined shall be documented.

2.6 Sample Summary Values

2.6.1 Statistics

For lots submitted under the sampling-by-variables plans, the statistics specified in those plans shall be calculated from the quantitative characteristics of the sample units.

2.6.2 Counts

2.6.2.1 For lots submitted under the sampling-by-attributes plans, the counts specified in those plans shall be determined for the quantitative and qualitative characteristics of the sample units.

2.6.2.2 For lots submitted under the sampling-by-variables plans, the counts specified in those plans shall be determined for the qualitative characteristics of the sample units.

2.6.3 Serious Nonconforming Units

2.6.3.1 For all lots submitted for sampling inspection, the number of serious nonconforming units in the sample shall be counted and be designated by the symbol r_s.

2.6.3.2 The criteria for determining whether a unit is a serious nonconforming unit are specified in Part 2 of this document, according to the type of product.

2.7 Acceptance Criteria

2.7.1 Lot Acceptability. Each lot shall be considered to be acceptable if all of the following conditions are met:

(a) the prerequisites specified in clause 2.2 have been verified as being met;

(b) the requirements for lot formation specified in clause 2.3 have been verified as being met;

(c) the requirements for sample selection specified in clause 2.4 have been verified as being met;

(d) the requirements for product inspection specified in clause 2.5 have been verified as being met; and

(e) the sample summary values meet the acceptance criteria defined in the specific sections of this document according to the type of sampling and type of product.

2.7.2 Sample Acceptability. Each unit in the sample shall be considered to be acceptable if all of the following conditions are met:

(a) the lot is considered acceptable;

(b) the unit complies with all specified requirements; and

(c) the unit does not possess any defect which could affect its ability to meet specified requirements during its usage.

2.8 Disposition of Nonconformances

2.8.1 Unacceptable lots may be resubmitted for inspection only after the organization has re-examined all units and removed or corrected all nonconforming or defective units.

2.8.2 Individual nonconforming or defective units may be resubmitted for evaluation only after all of their deficient characteristics have been corrected.

2.9 Sampling Inspection Switching Schemes

2.9.1 Criteria for switching between different types or levels of sampling inspection are given in the relevant sections of this document, where applicable.

2.9.2 Operation under a particular type or level of sampling inspection shall be based solely on inspection results from lots of the same homogeneity classification. The sampling inspection type or level for lots from different homogeneity classifications shall be determined independently.

2.9.3 The organization may elect to have sampling inspection for lots of a given homogeneity classification performed at a level more stringent than lot quality supports. However, this fact shall not alter the operation of the switching schemes in any other regard.

2.10 Discontinuation of Sampling Inspection

2.10.1 Failure to maintain effective, on-going compliance with the prerequisites as required by clause 2.2 shall be grounds for discontinuation of sampling inspection.

2.10.2 Deliberate or negligent inclusion of nonconforming or defective units of product in lots submitted for evaluation shall be grounds for discontinuation of sampling inspection.

2.10.3 Criteria for the discontinuation of sampling inspection under other circumstances are specified in the relevant sections of this document, where applicable.

2.11 Resumption of Sampling Inspection

2.11.1 Sampling inspection discontinued under the requirement of clause 2.10.1 or 2.10.2 may be resumed following the development of effective corrective and preventive actions by the organization, and Measurement Canada evaluation and acceptance of these actions.

2.11.2 Criteria for the resumption of sampling inspection under other circumstances are specified in the relevant sections of this document, where applicable.

2.12 Records

The following records shall be kept for each lot submitted for acceptance sampling inspection:

(a) a sorted listing of the units in the lot, including the identification numbers, makes, models, and metrological parameters of each unit, as applicable;

(b) the lot identification number;

(c) the lot size;

(d) where the lot is composed of products with differing physical characteristics, the size of each sub-lot;

(e) the production status of the product in the lot;
(f) evidence that all criteria for lot acceptance have been verified, including identification of the person(s) who performed the verifications;

(g) the sample size;

(h) a listing of the sample units selected;

(i) the inspection and test results for each characteristic of each sample unit evaluated;

(j) identification of sample selection method used and the information required by clause 2.4.4 or 2.4.5, as the case may be;

(k) whether sampling by attributes or sampling by variables was used;

(l) the inspection level used and the evidence necessary to support operation at that level;

(m) the sample summary values for each quality characteristic;

(n) the status of the lot following sampling inspection;

(o) the date(s) of lot production, sample selection, and sample inspection;

(p) the name of the inspector who performed the inspections;

(q) the identification numbers of all measurement standards used in the inspection of the product;

(r) where sampling inspection has been discontinued, any information required pursuant to clause 2.11.1 to support resumption of sampling inspection;

(s) a copy of the certificate issued for the inspection of the lot.

2.13 Tables

Tables to support the operation of the sampling plans are provided in the relevant sections of this document, where applicable.

3. Acceptance Sampling by Attributes

3.1 Scope

3.1.1 This section specifies the requirements for the evaluation of eligible product by the acceptance sampling-by-attributes method.

3.1.2 The requirements of this section shall apply to products which have been identified in Part 2 of this document as being eligible for evaluation by the sampling-by-attributes method and to products which no longer qualify for evaluation by the sampling-by-variables method due to the distributional form of their quantitative characteristics.

3.2 Prerequisites to Sampling Inspection

In addition to the requirements of clause 2.2, the product type shall be identified in Part 2 of this document as being eligible for evaluation by the acceptance sampling-by-attributes method.

3.3 Lot Formation

In addition to the requirements of clause 2.3, where inspection level switching is permitted and being used, for all lots subsequent to the third lot submitted for inspection under this section, the size of the lot shall not be larger than 150% of the mean of immediately preceding 3 lots.

3.4 Sample Selection

In addition to the requirements of clause 2.4, the following apply.

3.4.1 Subject to clause 3.4.2, the number of sample units to be selected and inspected shall be determined from Table 3.1 in clause 3.13, according to the lot size and inspection level.

3.4.2 Where a product type eligible for sampling-by-variables is evaluated under these sampling plans, all inspections shall be performed at the level 1 rating.

3.5 Product Inspection and Quality Characteristics

The requirements of clause 2.5 apply.

3.6 Sample Summary Values

In addition to the requirements of clause 2.6, the following apply.

3.6.1 Counts

The number of nonconforming units in the sample shall be counted and be designated by the symbol r.

3.6.2 Serious Nonconforming Units

The requirements of clause 2.6.3 apply.

3.7 Acceptance Criteria

In addition to the requirements of clause 2.7, the lot shall be considered to be acceptable if both of the following criteria are satisfied:

(a) $r \bullet c$; and

(b) $r_s = 0$

where c is the value in Table 3.1, corresponding to the sample size and level of inspection.

3.8 Disposition of Nonconformances

The requirements of clause 2.8 apply.

3.9 Sampling Inspection Switching Schemes

3.9.1 Inspection Level Switching Rules

3.9.1.1 Subject to clause 3.9.1.2, Level 1 inspection shall be used at the start of inspection and shall continue to be used during the course of inspection until either the criteria for Level 2 inspection are satisfied or the criteria for discontinuation of sampling in clause 3.10 are met.

3.9.1.2 Level 2 inspection may be instituted when 5 consecutive homogeneous lots have been accepted on original Level 1 inspection.

3.9.1.3 Level 1 inspection shall be re-instituted when 2 lots within any 5 or less consecutive homogeneous lots are rejected on original Level 2 inspection .

3.9.1.4 Level 3 inspection may be instituted when 5 consecutive homogeneous lots have been accepted on original Level 2 inspection.

3.9.1.5 Level 2 inspection shall be re-instituted when the following conditions are met:

(a) a lot is rejected on Level 3 inspection; or

(b) the period between submission of lots of a given homogeneity classification exceeds 6 weeks in

duration.

3.9.2 Switching to Sampling by Variables

Subsequent lots may be submitted for evaluation by the sampling-by-variables method provided that all of the following conditions are satisfied:

(a) the product type is identified in the Part 2 of this document as being eligible for evaluation by the sampling-by-variables method;
(b) the preceding 5 consecutive homogeneous lots have not been rejected on original inspection; and
(c) the quantitative characteristics of the cumulative sample of the preceding 5 consecutive homogeneous lots meet the criteria for distributional form as specified in clause 4.7(b) of this document.

3.10 Discontinuation of Sampling Inspection

3.10.1 In the event that 2 out of 5 or less consecutive homogeneous lots are rejected on original Level 1 inspection, sampling inspection shall be discontinued.

3.10.2 In the event that 10 consecutive lots remain on Level 1 inspection, sampling inspection shall be suspended until effective corrective action has been implemented to prevent recurrence of the nonconformities or defects causing continuation at Level 1 inspection.

3.11 Resumption of Sampling Inspection

Sampling inspection discontinued under the requirements of clause 3.10 may be resumed following the development of effective corrective and preventive actions by the organization and Measurement Canada evaluation and acceptance of these actions.

3.12 Records

The requirements of clause 2.12 apply.

3.13 Tables

Table 3.1 defines the sample sizes and the acceptance numbers to be used for lots of various sizes, under the different inspection levels, being evaluated for acceptance

Table 3.1

N	*n, c*		
	Level 1	**Level 2**	**Level 3**
90 or less	20, 0	13, 0	13, 0
91 to 150	32, 0	20, 0	13, 0
151 to 280	50, 1	32, 0	20, 0
281 to 500	80, 2	50, 1	32, 0
501 to 1200	125, 3	80, 2	50, 1
1201 to 3200	200, 5	125, 3	80, 2
3201 to 10000	315, 7	200, 5	125, 3

4. Acceptance Sampling by Variables

4.1 Scope

This section specifies the requirements for the evaluation of eligible product by the sampling-by-variables method.

4.2 Prerequisites to Sampling Inspection

In addition to the requirements of clause 2.2, the product type shall be identified in Part 2 of this document as being eligible for evaluation by the acceptance sampling-by-variables method.

4.3 Lot Formation

In addition to the requirements of clause 2.3, where inspection level switching is permitted and being used, for all lots subsequent to the third lot submitted for inspection under this section, the size of the lot shall not be larger than 150% of the mean of immediately preceding 3 lots.

4.4 Sample Selection

In addition to the requirements of clause 2.4, the number of sample units to be selected and inspected shall be determined from Table 4.1 in clause 4.13, according to the lot size and inspection level.

4.5 Product Inspection and Quality Characteristics

The requirements of clause 2.5 apply.

4.6 Sample Summary Values

In addition to the requirements of clause 2.6, the following apply.

4.6.1 Statistics

The following statistics shall be calculated from the observations (x_i) corresponding to each quantitative characteristic of the sample units:

(a) $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n}$; and

(b) $s = \sqrt{\dfrac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$.

4.6.2 Counts

For the qualitative characteristics of the sample units, the number of nonconforming units in the sample, excluding those resulting from the evaluation of the quantitative characteristics, shall be counted and be designated by the symbol r.

4.6.3 Serious Nonconforming Units

The requirements of clause 2.6.3 apply.

4.7 Acceptance Criteria

In addition to the requirements of clause 2.7, the lot shall be considered to be acceptable if all of the following conditions are met:

(a) the following three inequalities are satisfied simultaneously for each quantitative characteristic:

(i) $x + k \cdot s \bullet U$,

(ii) $x \bullet k \cdot s \bullet L$, and

(iii) $s \bullet f \cdot (U \bullet L)$;

(b) for the cumulative sample comprised of the current sample and the immediately preceding 4 homogeneous samples, the set of observations ($\{x_i\}$ where $i = 1$ to n) corresponding to each quantitative characteristic satisfy either of the following two distributional form criteria:

(i) the set of observations $\{x_i\}$ is accepted under the test for normality in document S-S-03, or

(ii) $\frac{1}{4} \cdot (U + 3 \cdot L) \bullet \{x_i\} \bullet \frac{1}{4} \cdot (3 \cdot U + L)$ (where $i = 1$ to n);

(c) the number of nonconforming units due to qualitative characteristic nonconformities do not exceed the acceptance number (i.e., $r \bullet c$); and

(d) $r_s = 0$,

where:

k, f, and c are as specified in Table 4.2, according to the sample size; and
U and L are the upper and lower tolerance limits as defined in the applicable product specifications according to the product type and characteristic.

4.8 Disposition of Nonconformances

4.8.1 Subject to clause 4.8.2, lots rejected on original inspection may be resubmitted for inspection only after their deficient characteristics have been corrected. These reworked lots shall be evaluated at the next more stringent inspection level where applicable, or inspection level 1, but shall not have any further effect in the inspection level determinations unless the lot is rejected again.

4.8.2 Lots rejected on the basis of the criteria of clause 4.7(a) or clause 4.7(b) may be re-evaluated in accordance with clause 4.9.2 at the option of the owner, but shall not have any further effect in the inspection level determinations unless the lot is rejected again.

4.9 Sampling Inspection Switching Schemes

4.9.1 Inspection Level Switching Rules

4.9.1.1 Subject to clause 4.9.1.2, Level 1 inspection shall be used at the start of inspection and shall continue to be used during the course of inspection until either the criteria for Level 2 inspection are

satisfied or the criteria for discontinuation of sampling in clause 4.8 are met.

4.9.1.2 Level 2 inspection may be instituted when 5 consecutive homogeneous lots have been accepted on original Level 1 inspection.

4.9.1.3 Level 1 inspection shall be re-instituted when 2 lots within any 5 or less consecutive homogeneous lots are rejected on original Level 2 inspection.

4.9.1.4 Level 3 inspection may be instituted when 5 consecutive homogeneous lots have been accepted on original Level 2 inspection.

4.9.1.5 Level 2 inspection shall be re-instituted when the following conditions are met:

(a) a lot is rejected on Level 3 inspection; or

(b) the period between submission of lots of a given homogeneity classification exceeds 6 weeks in duration.

4.9.2 Switching to Sampling by Attributes

Where the inspection results of a sample fail to satisfy the criteria of clause 4.7 but would potentially meet the acceptance criteria of clause 3.7, an additional sample equal to the difference between the current sample size and the sample size required by section 3 of this document for level 1 inspection may be selected and inspected. The acceptance criteria of section 3 of this document shall then apply to the combined sample.

4.10 Discontinuation of Sampling Inspection

4.10.1 In the event that 2 out of 5 or less consecutive homogeneous lots are rejected on original Level 1 inspection, sampling-by-variables inspection shall be discontinued.

4.10.2 Where the criterion of clause 4.10.1 is met but the criterion of clause 3.10 has not been met, sampling inspection may continue under the provisions of section 3 of this document.

4.10.3 Where the criteria of clauses 4.10.1 and 3.10 have both been met, sampling inspection shall be discontinued.

4.10.4 In the event that 10 consecutive lots remain on Level 1 inspection, sampling inspection shall be suspended until effective corrective action has been implemented to prevent recurrence of the nonconformities or defects causing continuation at Level 1 inspection.

4.11 Resumption of Sampling Inspection

Sampling inspection discontinued under the requirements of clause 4.10 may be resumed following the development of effective corrective and preventive actions by the organization and Measurement Canada evaluation and acceptance of these actions.

4.12 Records

In addition to the requirements of clause 2.12, the following records shall be kept:

(a) the nature of the test for distributional form; and

(b) the statistics calculated to support the distributional form conclusion.

4.13 Tables

4.13.1 Table 4.1 defines the sample sizes to be used at the different inspection levels for lots of various sizes being evaluated for acceptance

Table 4.1

N	*n*		
	Level 1	**Level 2**	**Level 3**
90 or less	15	7	5
91 to 150	20	10	7
151 to 280	25	15	10
281 to 500	35	25	15
501 to 1200	50	35	20
1201 to 3200	75	50	25
3201 to 10000	100	75	35

4.13.2 Table 4.2 defines the acceptance numbers, acceptability constants, and factors for calculation of maximum standard deviation to be used for samples of various sizes being evaluated for acceptance.

Table 4.2

n	*c*	*k*	*f*
5	0	1.53	0.308
7	0	1.62	0.280
10	0	1.72	0.261
15	0	1.79	0.248
20	0	1.82	0.242
25	0	1.85	0.238
35	0	1.89	0.232
50	0	1.93	0.227
75	1	1.98	0.223
100	2	2.00	0.220

SECTION 05
ACCEPTANCE SAMPLING PLANS - PART 2

Contents

1. Scope

1.1 General

This document specifies the requirements for the evaluation of specific types of products on a lot-by-lot basis through the use of acceptance sampling methods.

1.2 Applicability

This document establishes requirements which apply in addition to those specified in Part 1, according to the type of product.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-04: *Statistical Methods for Metrological Control — Statistical Tests.*

S-S-05: *Statistical Methods for Metrological Control — Acceptance Sampling Plans (Part 1).*

PS-E-XX: *Provisional Specifications for Electricity Meter Verification and Reverification.*

PS-G-XX: *Provisional Specifications for Gas Meter Verification and Reverification.*

PS-EG-XX: *Provisional Specifications for Electricity and Gas Telemetering Systems.*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

The responsibilities in document S-S-05: Part 1 apply.

2. Electro-Mechanical Electricity Energy Meters

2.1 General

2.1.1 This section establishes the specific acceptance sampling requirements for electro-mechanical type, electricity energy meters.

2.1.2 This meter type may be evaluated by the sampling-by-variables method or the sampling-by-attributes method, subject to the prerequisites and requirements of those methods contained in Part 1 of this document and the requirements of this section.

2.2 Prerequisites to Sampling Inspection

The requirements of clause 2.2 in Part 1 apply.

2.3 Lot Formation

2.3.1 Newly-Manufactured Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) manufacturer;
(b) model;
(c) design parameters, including voltage and current ratings, configuration, and features; and
(d) production and quality control methods.

2.3.2 Reconditioned Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) design parameters, including voltage and current ratings, configuration, and features; and
(b) production and quality control methods

2.4 Sample Selection

2.4.1 The requirements of clauses 2.4 and 4.4 in Part 1 apply for sampling-by-variables.

2.4.2 The requirements of clauses 2.4 and 3.4.2 in Part 1 apply for sampling-by-attributes.

2.5 Product Inspection and Quality Characteristics

In addition to the requirements of clause 2.5 in Part 1, the following requirements apply.

2.5.1 Quantitative Characteristics

The meter's calibration performance errors at each test point specified in reference document PS-E-XX shall be assessed as quantitative characteristics under the sampling-by-variables plans.

2.5.2 Qualitative Characteristics

2.5.2.1 The meter's calibration performance errors at each test point specified in reference document PS-E-XX shall be assessed as qualitative characteristics under the sampling-by-attributes plans.

2.5.2.2 All other quality characteristics shall be assessed as qualitative characteristics.

2.6 Sample Summary Values

2.6.1 The requirements of clause 4.6 in Part 1 apply for statistics of each quantitative characteristic and for counts of nonconforming units due to the aggregate of qualitative characteristics where sampling-by-variables is used.

2.6.2 The requirements of clause 3.6 in Part 1 apply for counts of nonconforming units for each quantitative characteristic and for counts of nonconforming units due to the aggregate of qualitative characteristics where sampling-by-attributes is used.

2.6.3 The requirements of clause 2.6.3 in Part 1 shall apply for the number of serious nonconforming units as defined in clause 2.7.2, in each of the categories defined in clause 2.6.1 or 2.6.2, as the case may be

2.7 Acceptance Criteria

In addition to the requirements of clauses 2.7, 3.7, and 4.7 in Part 1, the following requirements apply.

2.7.1 The upper (U) and lower (L) tolerance limits for the meter's calibration performance errors at each test point shall be as specified in reference document PS-E-XX.

2.7.2 A meter shall be considered to be a serious nonconforming unit if one of the following criteria are met:

(a) a calibration error exceeds the upper or lower tolerance by 25% of the tolerance range;
(b) a registration error not due to calibration exists;
(c) a defect exists which could impair meter performance during use; or
(d) one or more nonconformities with respect to its pattern approval description exist.

2.7.3 The acceptance criteria of clause 4.7 in Part 1 shall be applied to each of the categories of characteristics defined in clauses 2.6.1 and 2.6.3 where sampling-by-variables is used.

2.7.4 The acceptance criteria of clause 3.7 in Part 1 shall be applied to each of the categories of characteristics defined in clauses 2.6.2 and 2.6.3 where sampling-by-attributes is used.

2.8 Disposition of Nonconformances

2.8.1 The requirements of clauses 2.8 and 4.8 in Part 1 apply for sampling-by-variables.

2.8.2 The requirements of clauses 2.8 and 3.8 in Part 1 apply for sampling-by-attributes.

2.9 Sampling Inspection Switching Schemes

2.9.1 The requirements of clauses 2.9 and 4.9 in Part 1 apply for sampling-by-variables.

2.9.2 The requirements of clause 3.4.2 in Part 1 apply for sampling-by-attributes.

2.10 Discontinuation of Sampling Inspection

2.10.1 The requirements of clauses 2.10 and 4.10 in Part 1 apply for sampling-by-variables.

2.10.2 The requirements of clauses 2.10 and 3.10 in Part 1 apply for sampling-by-attributes.

2.11 Resumption of Sampling Inspection

2.11.1 The requirements of clauses 2.11 and 4.11 in Part 1 apply for sampling-by-variables.

2.11.2 The requirements of clauses 2.11 and 3.11 in Part 1 apply for sampling-by-attributes.

2.12 Records

2.12.1 The requirements of clauses 2.12 and 4.12 in Part 1 apply for sampling-by-variables.

2.12.2 The requirements of clauses 2.12 and 3.12 in Part 1 apply for sampling-by-attributes.

2.13 Tables

2.13.1 The requirements of clauses 2.13 and 4.13 in Part 1 apply for sampling-by-variables.

2.13.2 The requirements of clauses 2.13 and 3.13 in Part 1 apply for sampling-by-attributes.

3. Diaphragm-type Gas Volumetric Meters

3.1 General

3.1.1 This section establishes the specific acceptance sampling requirements for diaphragm-type, gas volumetric meters.

3.1.2 This meter type may be evaluated by the sampling-by-variables method or the sampling-by-attributes method, subject to the prerequisites and requirements of those methods contained in Part 1 of this document and the requirements of this section.

3.2 Prerequisites to Sampling Inspection

The requirements of clause 2.2 in Part 1 apply.

3.3 Lot Formation

3.3.1 Newly-Manufactured Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) manufacturer;
(b) model;
(c) design parameters, including capacity and features; and
(d) production and quality control methods.

3.3.2 Reconditioned Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) design parameters, including capacity and features; and
(b) production and quality control methods.

3.4 Sample Selection

3.4.1 The requirements of clauses 2.4 and 4.4 in Part 1 apply for sampling-by-variables.

3.4.2 The requirements of clauses 2.4 and 3.4.2 in Part 1 apply for sampling-by-attributes.

3.5 Product Inspection and Quality Characteristics

In addition to the requirements of clause 2.5 in Part 1, the following requirements apply.

3.5.1 Quantitative Characteristics

The meter's calibration performance errors at each test point specified in reference document PS-G-XX shall be assessed as quantitative characteristics under the sampling-by-variables plans.

3.5.2 Qualitative Characteristics

3.5.2.1 The meter's calibration performance errors at each test point specified in reference document PS-G-XX shall be assessed as qualitative characteristics under the sampling-by-attributes plans.

3.5.2.2 All other quality characteristics shall be assessed as qualitative characteristics.

3.6 Sample Summary Values

3.6.1 The requirements of clause 4.6 in Part 1 apply for statistics of each quantitative characteristic and for counts of nonconforming units due to the aggregate of qualitative characteristics where sampling-by-variables is used.

3.6.2 The requirements of clause 3.6 in Part 1 apply for counts of nonconforming units for each quantitative characteristic and for counts of nonconforming units due to the aggregate of qualitative characteristics where sampling-by-attributes is used.

3.6.3 The requirements of clause 2.6.3 in Part 1 shall apply for the number of serious nonconforming units as defined in clause 3.7.2, in each of the categories defined in clause 3.6.1 or 3.6.2, as the case may be.

3.7 Acceptance Criteria

In addition to the requirements of clauses 2.7, 3.7, and 4.7 in Part 1, the following requirements apply.

3.7.1 The upper (U) and lower (L) tolerance limits for the meter's calibration performance errors at each test point shall be as specified in reference document PS-G-XX.

3.7.2 A meter shall be considered to be a serious nonconforming unit if one of the following criteria are met:

(a) a calibration error exceeds the upper or lower tolerance by 25% of the tolerance range;
(b) a registration error not due to calibration exists;
(c) a defect exists which could impair meter performance during use; or

(d) one or more nonconformities with respect to its pattern approval description exist.

3.7.3 The acceptance criteria of clause 4.7 in Part 1 shall be applied to each of the categories of characteristics defined in clauses 3.6.1 and 3.6.3 where sampling-by-variables is used.

3.7.4 The acceptance criteria of clause 3.7 in Part 1 shall be applied to each of the categories of characteristics defined in clauses 3.6.2 and 3.6.3 where sampling-by-attributes is used.

3.8 Disposition of Nonconformances

3.8.1 The requirements of clauses 2.8 and 4.8 in Part 1 apply for sampling-by-variables.

3.8.2 The requirements of clauses 2.8 and 3.8 in Part 1 apply for sampling-by-attributes.

3.9 Sampling Inspection Switching Schemes

3.9.1 The requirements of clauses 2.9 and 4.9 in Part 1 apply for sampling-by-variables.

3.9.2 The requirements of clause 3.4.2 in Part 1 apply for sampling-by-attributes.

3.10 Discontinuation of Sampling Inspection

3.10.1 The requirements of clauses 2.10 and 4.10 in Part 1 apply for sampling-by-variables.

3.10.2 The requirements of clauses 2.10 and 3.10 in Part 1 apply for sampling-by-attributes.

3.11 Resumption of Sampling Inspection

3.11.1 The requirements of clauses 2.11 and 4.11 in Part 1 apply for sampling-by-variables.

3.11.2 The requirements of clauses 2.11 and 3.11 in Part 1 apply for sampling-by-attributes.

3.12 Records

3.12.1 The requirements of clauses 2.12 and 4.12 in Part 1 apply for sampling-by-variables.

3.12.2 The requirements of clauses 2.12 and 3.12 in Part 1 apply for sampling-by-attributes.

3.13 Tables

3.13.1 The requirements of clauses 2.13 and 4.13 in Part 1 apply for sampling-by-variables.

3.13.2 The requirements of clauses 2.13 and 3.13 in Part 1 apply for sampling-by-attributes.

4. Telemetering Systems

4.1 General

4.1.1 This section establishes the specific acceptance sampling requirements for telemetering systems used with electricity and gas meters.

4.1.2 This meter type may be evaluated by the sampling-by-attributes method, subject to the prerequisites and requirements of this method contained in Part 1 of this document and the requirements of this section.

4.2 Prerequisites to Sampling Inspection

The requirements of clause 2.2 in Part 1 apply.

4.3 Lot Formation

4.3.1 Newly-Manufactured Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) manufacturer;
(b) model;
(c) design parameters; and
(d) production and quality control methods.

4.3.2 Reworked or In-service Meters

Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) manufacturer;
(b) model;
(c) design parameters; and
(d) production and quality control methods

4.4 Sample Selection

The requirements of clauses 2.4 and 3.4 in Part 1 apply.

4.5 Product Inspection and Quality Characteristics

In addition to the requirements of clause 2.5 in Part 1, the following requirements apply.

4.5.1 The meter's performance error at the test point specified in reference document PS-EG-XX shall be assessed as a qualitative characteristic under the sampling-by-attributes plans.

4.5.2 All other quality characteristics shall be assessed as qualitative characteristics.

4.6 Sample Summary Values

The requirements of clause 2.6 in Part 1 shall apply such that counts of nonconforming units are summarized over the sample for each of the following characteristics:

(a) the performance of the meters;

(b) the aggregate of all other quality characteristics; and

(c) the number of serious nonconforming units as defined in clause 4.7.2, in each of the categories defined in items (a) and (b) above.

4.7 Acceptance Criteria

In addition to the requirements of clauses 2.7 and 3.7 in Part 1, the following requirements apply.

4.7.1 The upper (U) and lower (L) tolerance limits for the meter's performance error shall be as specified in reference document PS-EG-XX.

4.7.2 A meter shall be considered to be a serious nonconforming unit if one of the following criteria are met:

(a) the performance error exceeds the upper or lower tolerance by 25% of the tolerance range;
(b) a defect exists which could impair meter performance during use; or
(c) one or more nonconformities with respect to its pattern approval description exist.

4.7.3 The acceptance criteria of clause 3.7 in Part 1 shall be applied to each of the categories of characteristics defined in clause 4.6.

4.8 Disposition of Nonconformances

The requirements of clauses 2.8 and 3.8 in Part 1 apply.

4.9 Sampling Inspection Switching Schemes

The requirements of clauses 2.9 and 3.9 in Part 1 apply.

4.10 Discontinuation of Sampling Inspection

The requirements of clauses 2.10 and 3.10 in Part 1 apply.

4.11 Resumption of Sampling Inspection

The requirements of clauses 2.11 and 3.11 in Part 1 apply.

4.12 Records

The requirements of clauses 2.12 and 3.12 in Part 1 apply.

4.13 Tables

The requirements of clauses 2.13 and 3.13 in Part 1 apply.

SECTION 06

Compliance Sampling Plans

Contents

1. Scope

1.1 General

1.1.1 This document specifies the requirements for the evaluation of products on a lot-by-lot basis through the use of compliance sampling methods.

1.1.2 The object of the sampling plans laid out in this document is to ensure that lots of unacceptable quality have a high probability of rejection and that the probability of acceptance for lots of adequate quality is as high as possible.

1.2 Applicability

1.2.1 The sampling plans in this document are designed for assessing the quality of discrete lots of homogeneous products.

1.2.2 The sampling-by-attributes plans are applicable for assessing the quality of product characteristics which are measurable on a discrete or continuous scale, regardless of their distributional form.

1.2.3 The sampling-by-variables plans are applicable for assessing the quality of product characteristics which are measurable on a continuous scale and are distributed according to a normal distribution.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-02: *Statistical Methods for Metrological Control — Quality System Requirements.*

S-S-03: *Statistical Methods for Metrological Control — General Methods.*

S-S-04: *Statistical Methods for Metrological Control — Statistical Tests.*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

1.5.1 The organization submitting product intended for evaluation by compliance sampling methods shall be responsible for:

(a) documenting, implementing, and maintaining a quality system in accordance with document S-S-02 which preserves the integrity of products at a quality level adequate for compliance sampling inspection;

(b) taking appropriate corrective action on all nonconformances reported by the inspector or auditor, or otherwise discovered; and

(c) maintaining all records necessary to support the continuation of the use of compliance sampling and making these records available for review on request.

1.5.2 The organization wishing to evaluate product by compliance sampling methods shall be responsible for:

(a) documenting, implementing, and maintaining a quality system in accordance with document S-S-02 to ensure the requirements of this document are met;

(b) taking appropriate corrective action on all nonconformances reported or otherwise discovered;

(c) maintaining all records required by this document and making these records available for review on request; and

(d) the production quality of the product shall meet the criteria specified in section 4 of document S-S-03.

2. General Requirements

2.1 Scope

2.1.1 This section specifies the general requirements for the evaluation of product by compliance sampling methods.

2.1.2 The requirements in this section apply in addition to those of other sections of this document.

2.2 Prerequisites to Sampling Inspection

Before compliance sampling methods may be used to evaluate a product, all of the following conditions shall be met:

(a) the organization wishing to use compliance sampling methods shall develop, implement, obtain authorization of, and maintain a quality system in accordance with document S-S-02;

(b) the product type shall be one of those identified in Part 2 of this document as being eligible for evaluation by compliance sampling;

(c) the subject product shall be verified as having been preserved under the controlled conditions of the quality system; and

(d) the quality of the product shall meet the criteria specified in section 4 of document S-S-03.

2.3 Lot Formation

2.3.1 A lot shall be formed only from product specifically identified in Part 2 of this document as being eligible for evaluation by compliance sampling methods.

2.3.2 The lot shall be formed only from product that is available for sample selection.

2.3.3 The composition of the lot shall comply with the criteria for lot homogeneity as defined in the applicable section in Part 2 of this document.

2.3.4 All units of product in the lot shall be individually identified on a list by the owner and arranged in ascending order based on product identification numbers.

2.4 Sample Selection

2.4.1 The sample shall be chosen from the lot listing by the inspector.

2.4.2 The size of the sample to be selected shall be determined in accordance with the criteria specified for the particular type of sampling being used.

2.4.3 The sample shall be selected from the lot based on either the random sampling method using authorized tables of uniformly-distributed random numbers or the pseudo-random sampling method using an authorized computer algorithm for pseudo-random number generation.

2.4.4 Where uniformly-distributed random number tables are used, the coordinates of the initially selected value and the direction taken for selecting successive values shall be recorded.

2.4.5 Where pseudo-random sampling is used, the value of the seed shall be recorded.

2.5 Product Inspection and Quality Characteristics

2.5.1 Each sample unit of product shall be examined for conformance to all pertinent acceptance requirements, according to the type of product.

2.5.2 Each sample unit of product shall be prepared for test and inspected in accordance with product-specific documented procedures which have been authorized by Measurement Canada.

2.5.3 All sample units shall be inspected under identical conditions, within as short a time period as is practicable to achieve valid inspection results.

2.5.4 The identification of each sample unit and the test results for each quality characteristic examined shall be documented.

2.6 Sample Summary Values

2.6.1 Statistics

For lots submitted under the sampling-by-variables plans, the statistics specified in those plans shall be calculated from the quantitative characteristics of the sample units.

2.6.2 Counts

2.6.2.1 For lots submitted under the sampling-by-attributes plans, the counts specified in those plans shall be determined for the quantitative and qualitative characteristics of the sample units.

2.6.2.2 For lots submitted under the sampling-by-variables plans, the counts specified in those plans shall be determined for the qualitative characteristics of the sample units.

2.7 Acceptance Criteria

2.7.1 Lot Acceptability. Each lot shall be considered to be acceptable if all of the following conditions are met:

(a) the prerequisites specified in clause 2.2 have been verified as being met;

(b) the requirements for lot formation specified in clause 2.3 have been verified as being met;

(c) the requirements for sample selection specified in clause 2.4 have been verified as being met;

(d) the requirements for product inspection specified in clause 2.5 have been verified as being met; and

(e) the sample summary values meet the acceptance criteria defined in the specific sections of this document according to the type of sampling and type of product.

2.7.2 Sample Acceptability. Each unit in the sample shall be considered to be acceptable if all of the following conditions are met:

(a) the lot is considered acceptable;

(b) the unit complies with all specified requirements; and

(c) the unit does not possess any defect which could affect its ability to meet specified requirements during its usage.

2.8 Disposition of Nonconformances

2.8.1 Unacceptable lots may be resubmitted for inspection only after the organization has re-examined all units and removed or corrected all nonconforming or defective units.

2.8.2 Individual nonconforming or defective units may be resubmitted for evaluation only after all of their deficient characteristics have been corrected.

2.9 Sampling Inspection Switching Schemes

Criteria for switching between different types of sampling inspection are given in the relevant sections of this document, where applicable.

2.10 Discontinuation of Sampling Inspection

2.10.1 Failure to maintain effective, on-going compliance with the prerequisites as required by clause 2.2 shall be grounds for discontinuation of sampling inspection.

2.10.2 Deliberate or negligent modification of any unit of product submitted for evaluation shall be grounds for discontinuation of sampling inspection.

2.10.3 Criteria for the discontinuation of sampling inspection under other circumstances are specified in the relevant sections of this document, where applicable.

2.11 Resumption of Sampling Inspection

2.11.1 Sampling inspection discontinued under the requirement of clause 2.10.1 or 2.10.2 may be resumed following the development of effective corrective and preventive actions by the organization, and Measurement Canada evaluation and acceptance of these actions.

2.11.2 Criteria for the resumption of sampling inspection under other circumstances are specified in the relevant sections of this document, where applicable.

2.12 Records

The following records shall be kept for each lot submitted for compliance sampling inspection:

(a) a sorted listing of the units in the lot, including the identification numbers, makes, models, and metrological parameters of each unit, as applicable;

(b) the lot identification number;

(c) the lot size;

(d) where the lot is composed of products with differing physical characteristics, the size of each sub-lot;

(e) the production status of the product in the lot;

(f) evidence that all criteria for lot acceptance have been verified, including identification of the person(s) who performed the verifications;

(g) the sample size;

(h) a listing of the sample units selected;

(i) the inspection and test results for each characteristic of each sample unit evaluated;

(j) identification of sample selection method used and the information required by clause 2.4.4 or 2.4.5, as the case may be;

(k) whether sampling by attributes or sampling by variables was used;

(l) the sample summary values for each quality characteristic;

(m) where additional sampling has been authorized and used, the quality characteristic summary values for both the initial and combined samples;

(n) the number of sample units contributing to the calculated statistics;

(o) a documented explanation accounting for all sample units selected but not tested, including corrective and preventive action details where applicable;

(p) the number of units removed from the lot and the adjusted lot size;

(q) the status of the lot following sampling inspection;

(r) the date(s) of lot production, sample selection, and sample inspection;

(s) the name of the inspector who performed the inspections;

(t) the identification numbers of all measurement standards used in the inspection of the product;

(u) where sampling inspection has been discontinued, any information required pursuant to clause 2.11.1 to support resumption of sampling inspection; and

(v) a copy of the certificate issued for the inspection of the lot.

2.13 Tables

Tables to support the operation of the sampling plans are provided in the relevant sections of this document, where applicable.

3. Compliance Sampling by Attributes

3.1 Scope

3.1.1 This section specifies the requirements for the evaluation of eligible product by the compliance sampling-by-attributes method.

3.1.2 The requirements of this section shall apply to products which have been identified in Part 2 of this document as being eligible for evaluation by the sampling-by-attributes method and to products which no longer qualify for evaluation by the sampling-by-variables method due to the distributional form of their quantitative characteristics.

3.2 Prerequisites to Sampling Inspection

In addition to the requirements of clause 2.2, the product type shall be identified in Part 2 of this document as being eligible for evaluation by the compliance sampling-by-attributes method.

3.3 Lot Formation

The requirements of clause 2.3 apply.

3.4 Sample Selection

In addition to the requirements of clause 2.4, the following apply.

3.4.1 Subject to clause 3.4.2, the number of sample units to be selected for inspection shall be determined from Table 3.1 in clause 3.13, according to the lot size.

3.4.2 At the option of the owner, a larger sample size corresponding to one of the values in Table 3.1 may be selected.

3.5 Product Inspection and Quality Characteristics

The requirements of clause 2.5 apply.

3.6 Sample Summary Values

In addition to the requirements of clause 2.6, the following apply.

The number of nonconforming units in the sample shall be counted and be designated by the symbol r.

3.7 Acceptance Criteria

In addition to the requirements of clause 2.7, the lot shall be considered to be acceptable if the following criterion is satisfied:

$r \bullet c$

where c is the value in Table 3.1, corresponding to the sample size.

3.8 Disposition of Nonconformances

The requirements of clause 2.8 apply.

3.9 Sampling Inspection Switching Schemes

Sampling inspection switching schemes are not applicable.

3.10 Discontinuation of Sampling Inspection

The requirements of clause 2.10 apply.

3.11 Resumption of Sampling Inspection

The requirements of clause 2.11 apply.

3.12 Records

The requirements of clause 2.12 apply.

3.13 Tables

Table 3.1 defines the sample sizes and the acceptance numbers to be used for lots of various sizes being evaluated for acceptance.

Table 3.1

N	*n*	*c*
1 000 or less	298	0
1 001 to 2 500	388	0
2 501 to 5 000	472	1
5 001 to 10 000	531	1
10 001 to 15 000	666	2
15 001 to 25 000	797	3
25 001 to 50 000	925	4

4. Compliance Sampling by Variables

4.1 Scope

This section specifies the requirements for the evaluation of eligible product by the compliance sampling-by-variables method.

4.2 Prerequisites to Sampling Inspection

In addition to the requirements of clause 2.2, the following apply.

4.2.1 The product type shall be identified in Part 2 of this document as being eligible for evaluation by the compliance sampling-by-variables method.

4.2.2 The distributional form of the product's quantitative characteristics, as determined through qualification for sampling inspection in accordance with section 4 of document S-S-03 or through previous lot inspection, as the case may be, shall meet the requirements of clause 4.7(b).

4.3 Lot Formation

The requirements of clause 2.3 apply.

4.4 Sample Selection

In addition to the requirements of clause 2.4, the following apply.

4.4.1 Subject to clause 4.4.2, the number of sample units to be selected for inspection shall be determined from Table 4.1 in clause 4.13, according to the lot size.

4.4.2 At the option of the owner, a larger sample size corresponding to one of the values in Table 3.1 may be selected.

4.5 Product Inspection and Quality Characteristics

The requirements of clause 2.5 apply.

4.6 Sample Summary Values

In addition to the requirements of clause 2.6, the following apply.

4.6.1 Statistics

The following statistics shall be calculated from the observations (x_i) corresponding to each quantitative characteristic of the sample units:

(a) $\bar{x} = \dfrac{\sum_{i=1}^{n} x_i}{n}$; and

(b) $s = \sqrt{\dfrac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$.

4.6.2 Counts

For the qualitative characteristics of the sample units, the number of nonconforming units in the sample, excluding those resulting from the evaluation of the quantitative characteristics, shall be counted and be designated by the symbol r.

4.7 Acceptance Criteria

In addition to the requirements of clause 2.7, the lot shall be considered to be acceptable if all of the following conditions are met:

(a) the following three inequalities are satisfied simultaneously for each quantitative characteristic:

(i) $x + k \cdot s \leq U$,

(ii) $x \bullet k \cdot s \bullet L$, and

(iii) $s \bullet f \cdot (U \bullet L)$;

(b) the set of observations ($\{x_i\}$ where $i = 1$ to n) corresponding to each quantitative characteristic satisfy either of the following two distributional form criteria:

(i) the set of observations $\{x_i\}$ is accepted under the test for normality in document S-S-03, or

(ii) $\frac{1}{4} \cdot (U + 3 \cdot L) \bullet \{x_i\} \bullet \frac{1}{4} \cdot (3 \cdot U + L)$ (where $i = 1$ to n); and

(c) the number of nonconforming units due to qualitative characteristic nonconformities do not exceed the acceptance number (i.e., $r \bullet c$),

where:

k, f, and c are as specified in Table 4.1, according to the sample size; and

U and L are the upper and lower tolerance limits as defined in the applicable product specifications according to the product type and characteristic.

4.8 Disposition of Nonconformances

The requirements of clause 2.8 apply.

4.9 Sampling Inspection Switching Schemes

Where the inspection results of a sample fail to satisfy the criteria of clause 4.7 but would potentially meet the acceptance criteria of clause 3.7, an additional sample equal to the difference between the sample sizes required by sections 3 and 4 of this document may be selected and inspected. The acceptance criteria of section 3 of this document shall then apply to the combined sample.

4.10 Discontinuation of Sampling Inspection

The requirements of clause 2.10 apply.

4.11 Resumption of Sampling Inspection

The requirements of clause 2.11 apply.

4.12 Records

In addition to the requirements of clause 2.12, the following records shall be kept:

(a) the nature of the test for distributional form; and
(b) the statistics calculated to support the distributional form conclusion.

4.13 Tables

Table 4.1 defines the sample sizes and the acceptance numbers to be used for lots of various sizes being evaluated for acceptance.

Table 4.1

N	*n*	*k*	*c*	*MSD*
500 or less	25	3.158	0	0.5962
501 to 1 000	50	2.862	0	0.6504
1 001 to 2 500	75	2.748	0	0.6739
2 501 to 5 000	100	2.684	0	0.6877
5 001 to 10 000	150	2.611	0	0.7043
10 001 to 15 000	200	2.570	0	0.7139
15 001 to 25 000	250	2.542	0	0.7206
25 001 to 50 000	300	2.522	0	0.7255

SECTION 06 - PART 2

Compliance Sampling Plans

Contents

1. Scope

1.1 General

This document specifies the requirements for the evaluation of specific types of products on a lot-by-lot basis through the use of compliance sampling methods.

1.2 Applicability

This document establishes requirements which apply in addition to those specified in Part 1, according to the type of product.

1.3 Referenced Documents

The following documents are required for the interpretation and application of this document.

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-04: *Statistical Methods for Metrological Control — Statistical Tests.*

S-S-06: *Statistical Methods for Metrological Control — Compliance Sampling Plans (Part 1).*

PS-E-XX: *Provisional Specifications for Electricity Meter Verification and Reverification.*

PS-G-XX: *Provisional Specifications for Gas Meter Verification and Reverification.*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

The responsibilities in document S-S-06: Part 1 apply.

2. Electricity and Gas Meters

2.1 General

2.1.1 This section establishes the specific compliance sampling requirements for:

(a) electro-mechanical type, electricity energy meters; and
(b) diaphragm-type, gas volumetric meters.

2.1.2 The above meter types may be evaluated by the sampling-by-variables method or the sampling-by-attributes method, subject to the prerequisites and requirements of those methods as specified in Part 1 of this document and the requirements of this section.

2.2 Prerequisites to Sampling Inspection

In addition to the requirements of clause 2.2 in Part 1, the meter owner shall not have any overdue meters in service due to a failure to completely remove one or more lots previously rejected under compliance sampling.

2.3 Lot Formation

2.3.1 Each lot shall be formed from meters which are homogeneous with respect to the following criteria:

(a) type of meter;
(b) manufacturer and model;
(c) design parameters, including:
    (i) voltage and current ratings, measurement units, configuration, and features for electricity meters, and
    (ii) capacities, measurement units, and features for gas meters;
(d) owner and usage conditions;
(e) production status and year of original verification or reverification; and
(f) quality preservation methods.

2.3.2 For each lot that was previously submitted for compliance sampling, the lot shall include only meters which were defined in the previous lot listing with an account for any meters which have been removed from the lot since the previous sampling

2.4 Sample Selection

In addition to the requirements of clauses 2.4, 3.4, and 4.4 in Part 1, the following requirements apply.

2.4.1 The requirements of clauses 2.4 and 4.4 in Part 1 apply for sampling-by-variables.

2.4.2 The requirements of clauses 2.4 and 3.4 in Part 1 apply for sampling-by-attributes.

2.4.3 Additional Sampling

2.4.3.1 If, after analyzing the results of a single sample under the sampling-by-variables method, the owner of the lot believes that analysis of a larger sample would result in a more favourable outcome, the owner may elect to have one additional sample drawn from the lot of meters in service.

2.4.3.2 The size of the additional sample shall be equal to the difference between the value of n_{max} in Table 2.3 associated with the lot size that was used to select the first sample and the current value of n_{max}.

2.4.3.3 The decision regarding lot acceptability shall be determined in accordance with clause 2.7, based on an analysis of the combination of the two samples.

2.5 Product Inspection and Quality Characteristics

In addition to the requirements of clause 2.5 in Part 1, the following requirements apply.

2.5.1 Quantitative Characteristics

The meter's calibration performance errors at each test point specified in reference document PS-E-XX or PS-G-XX, as the case may be, shall be assessed as quantitative characteristics under the sampling-by-variables plans.

2.5.2 Qualitative Characteristics

2.5.2.1 The meter's calibration performance errors at each test point specified in reference document PS-E-XX or PS-G-XX, as the case may be, shall be assessed as qualitative characteristics under the sampling-by-attributes plans

2.5.2.2 All other quality characteristics shall be assessed as qualitative characteristics.

2.6 Sample Summary Values

2.6.1 Sampling by Variables

2.6.1.1 The statistics required by clause 4.6.1 in Part 1 shall be calculated for each quantitative characteristic.

2.6.1.2 The statistics corresponding to the test for distributional form required by clause 4.7(b) in Part 1 shall be calculated for each quantitative characteristic.

2.6.1.3 The count required by clause 4.6.2 in Part 1 shall be determined.

2.6.1.4 Where an observation (x_i) satisfies either of the following test criteria:

(a) $x_i > U_4$ and $x_i > x + 3 \cdot s$; or

(b) $x_i < L_4$ and $x_i < x - 3 \cdot s$

where x and s are calculated without including the observation x_i, and where U_4 and L_4 are defined in Table 2.5, the owner may elect to process the outlying observation as follows:

(c) if $x_i > U_4$, then let $x_i = U_4$; or

(d) if $x_i < L_4$, then let $x_i = L_4$,

count the number of values so processed (m), and recalculate the sample mean and standard deviation including the processed value.

2.6.1.5 The criteria of clause 2.6.1.4 may be used to test for more than one outlying observation at a time by excluding all suspected observations from the calculation of the mean and standard deviation before performing the tests.

2.6.2 Sampling by Attributes

The count required by clause 3.6 in Part 1 shall be applied as follows:

(a) for each quantitative characteristic, the number of nonconforming values exceeding the upper tolerance limit for level j ($r_j^{\bullet}$) shall be counted;

(b) for each quantitative characteristic, the number of nonconforming values exceeding the lower tolerance limit for level j ($r_j^{\bullet}$) shall be counted; and

(c) the number of nonconforming units due to all qualitative characteristics (r) shall be counted.

2.7 Acceptance Criteria

2.7.1 Sampling by Variables

In addition to the requirements of clause 4.7 in Part 1, the following requirements apply.

2.7.1.1 The requirement of clause 4.7(a) in Part 1 is modified such that the following inequalities shall be satisfied simultaneously for each quantitative characteristic, according to the acceptance level:

(a) Level 1:

(i) $x + k_1 \cdot s \bullet U_1$,

(ii) $x \bullet k_1 \cdot s \bullet L_1$,

(iii) $s \bullet MSD$, and

(iv) $m \bullet o_1$, or

(b) Level j (where $j = 2$, 3, or 4):

(i) $x + k_1 \cdot s \bullet U_j$,

(ii) $x \bullet k_2 \cdot s \bullet L_j$, and

(iii) $m \bullet o_j$,

where:

k_1, k_2, and MSD are the values specified in Table 2.2 or 2.3, as the case may be, according to lot size;

o_j is the value specified in Table 2.4, according to the sample size and acceptance level; and

U_j and L_j are the values specified in Table 2.5.

2.7.1.2 The requirement of clause 4.7(b) in Part 1 shall be interpreted such that the values of U and L correspond to the values of U_j and L_j in Table 2.5, according to the level j.

2.7.1.3 The requirement of clause 4.7(c) in Part 1 applies with the value of c being that specified in Table 2.1, according to the sample size.

2.7.1.4 The number of defective meters (n_d) established in accordance with clause 2.7.3 and the number meters involved in calculating the statistics (n) shall satisfy the following inequalities:

(a) $n_d \bullet n_d^{\bullet}$; and

(b) $n \bullet n_{max} \bullet n_j^{\bullet}$.

where:

n_{max} is the value specified in Table 2.2 or 2.3, as the case may be, according to lot size; and
$n_j^{\bullet}$ and $n_d^{\bullet}$ are the values specified in Table 2.4, corresponding to the sample size.

2.7.2 Sampling by Attributes

In addition to the requirements of clause 3.7 in Part 1, the following requirements apply.

2.7.2.1 The requirements of clause 3.7 in Part 1 is modified such that the following inequalities shall be satisfied simultaneously for each quantitative characteristic, according to the acceptance level:

(a) Level 1:

$r_1^{\bullet} \bullet r_1^{\bullet} \bullet c^{\bullet}$, or

(b) Level j (where j = 2, 3, or 4):

(i) $r_j^{\bullet} \bullet c^{\bullet}$; and

(ii) $r_j^{\bullet} \bullet c^{\bullet}$,

where $c^{\bullet}$ and $c^{\bullet}$ are the values specified in Table 2.1, corresponding to the sample size.

2.7.2.2 The number of nonconforming units due to qualitative characteristics (r), the number of defective meters (n_d), and the number of meters involved in determining the counts (n) shall satisfy the following inequalities:

(i) $r \bullet c^{\bullet}$;

(ii) $n_d \bullet n_d^{\bullet}$; and

(iii) $n \bullet n_{max} \bullet n_j^{\bullet}$,

where $c^{\bullet}$, $n_d^{\bullet}$, n_{max}, and $n_j^{\bullet}$ are the values specified in Table 2.1, corresponding to the sample size.

2.7.3 Sampling in General

In addition to the requirements of clauses 2.7, 3.7, and 4.7 in Part 1, the following requirements apply.

2.7.3.1 All meters selected for sampling inspection shall be accounted for in a documented manner by the meter owner, including the reasons for the exclusion or unavailability of any sample meter, and the documentation shall be made available for Measurement Canada review on request.

2.7.3.2 Each defective meter shall be preserved for Measurement Canada review and shall be the subject of an investigation by the meter owner to determine the cause of the defect or defects. A report shall be prepared and shall include the following information associated with this investigation:

(a) details of the meter's make, model, seal year, and identification numbers;

(b) a description of the defect and its effect on the meter's operation, including performance test results where feasible;

(c) a description of the steps taken to investigate the cause of the defect, including identification of the personnel both performing the investigation and providing information for its purpose;

(d) an explanation of how the defect occurred, including where it occurred in the process;

(e) an evaluation of the extent of the defect in the immediate situation as well as in situations likely to be similarly affected; and

(f) details of the corrective and preventive action proposed or performed to address the cause and symptoms of the defect.

2.7.3.3 In cases where a defective meter is encountered, the report required by clause 2.7.3.2 and the information required by clause 2.7.3.1 shall be provided to the local Measurement Canada representative for review prior to deciding upon the acceptability of the affected lot. Decisions regarding acceptability of the affected lot and the possible need for further investigation or corrective action shall not be made until Measurement Canada has evaluated the report and the statistical analysis of the data from the sample meters involved in the final calculations.

2.7.4 Reverification Period Extension

2.7.4.1 Where the requirements of clauses 2.7.1, 2.7.2, and 2.7.3 have been met, as applicable, the meters in lot shall be eligible for an extension to the reverification period previously assigned to the meters, based on both the type of meter and the acceptability level attained in the evaluation in accordance with the values in Table 2.6.

2.7.4.2 The expiry year of the lot's verification or reverification status shall be calculated by adding the extension determined in clause 2.7.4.1 to the calendar year in which the first sample meter was removed from service for evaluation.

2.8 Disposition of Nonconformances

2.8.1 The requirements of clauses 2.8 and 4.8 in Part 1 apply for sampling-by-variables.

2.8.2 The requirements of clauses 2.8 and 3.8 in Part 1 apply for sampling-by-attributes.

2.8.3 Subject to clause 2.8.4, rejected lots shall be removed from service by December 31 of the year corresponding to the expiry of the meters' verification or reverification status.

2.8.4 Where the quality of a rejected lot is such that, in the Director's opinion, the lot should be removed sooner than the deadline which would result from application of the requirement established in clause 2.8.3, the Director shall issue specific instructions to the lot owner with respect to the removal of the lot.

2.9 Sampling Inspection Switching Schemes

Where the inspection results of a sample evaluated under the sampling-by-variables method fail to satisfy the criteria of clause 2.7.1 but would potentially meet the acceptance criteria of clause 2.7.2, an additional sample equal to the difference between the sample sizes required by clauses 2.4.1 and 2.4.2 may be selected and inspected. The acceptance criteria of clause 2.7.2 shall then apply to the combined sample.

2.10 Discontinuation of Sampling Inspection

2.10.1 The requirements of clauses 2.10 and 4.10 in Part 1 apply for sampling-by-variables.

2.10.2 The requirements of clauses 2.10 and 3.10 in Part 1 apply for sampling-by-attributes.

2.10.3 Where heterogeneous meters are discovered in the sample or lot, compliance sampling shall be discontinued.

2.10.4 Where the requirements of clause 2.7.3 are not met to Measurement Canada's satisfaction, compliance sampling shall be discontinued.

2.11 Resumption of Sampling Inspection

2.11.1 The requirements of clauses 2.11 and 4.11 in Part 1 apply for sampling-by-variables.

2.11.2 The requirements of clauses 2.11 and 3.11 in Part 1 apply for sampling-by-attributes.

2.11.3 Sampling inspection discontinued under the requirements of clause 2.10.3 or 2.10.4 may be resumed following the development of effective corrective and preventive actions by the organization, and Measurement Canada evaluation and acceptance of these actions.

2.12 Records

In addition to the requirements of clauses 2.12, 3.12, and 4.12 in Part 1, the following records shall be kept for each lot submitted for compliance sampling inspection:

(a) a listing of the meters in the lot in ascending numerical order based on the meters' inspection numbers, including the inspection numbers, serial numbers, makes, models, and metrological parameters of each of the meters;

(b) the seal year of the meters in the lot;

(c) the results of any tests for distributional form, including all calculated statistics;

(d) the number of sample meters contributing to the calculated statistics;

(e) the number of sample meters rejected due to accuracy outside of reverification tolerance limits;

(f) the number of sample meters with broken or ineffective seals;

(g) the number of meters removed from the lot and the adjusted lot size;

(h) a list of the outliers detected in the sample, including their errors and the results of investigations to determine their cause;

(i) the documentation required by clause 2.7.3; and

(j) the amount of the extension to the reverification period granted and the year that the lot will be due for reverification.

2.13 Tables

2.13.1 Table 2.1 defines the minimum and maximum sample sizes, acceptance numbers, and maximum numbers of sample meters unavailable for testing associated with the four levels of acceptance to be used for lots of various sizes being evaluated by the compliance sampling by attributes method.

Table 2.1

N	n_{min}	n_{max}	c^+	$c^\bullet$	n_{1c}	n_{2c}	n_{3c}	n_{4c}	n_{5c}
1 000 or less	298	322	0	0	6	12	18	24	3
1 001 to 2 500	388	419	0	1	8	16	23	31	4
2 501 to 5 000	472	510	1	1	9	19	28	38	5

5 001 to 10 000	531	573	1	2	11	21	32	42	6
10 001 to 15 000	666	719	2	3	13	27	40	53	7
15 001 to 25 000	797	861	3	4	16	32	48	64	8
25 001 to 50 000	925	999	4	5	19	37	56	74	9

2.13.2 Table 2.2 defines the minimum and maximum sample sizes, acceptability constants, and values of maximum standard deviation to be used for lots of various sizes being evaluated by the compliance sampling by variables method.

Table 2.2

N	n_{min}	n_{max}	k_1	k_2	*MSD*
500 or less	25	27	3.158	2.952	0.5962
501 to 1 000	50	54	2.862	2.735	0.6504
1 001 to 2 500	75	81	2.748	2.649	0.6739
2 501 to 5 000	100	108	2.684	2.601	0.6877
5 001 to 10 000	150	162	2.611	2.546	0.7043
10 001 to 15 000	200	216	2.570	2.514	0.7139
15 001 to 25 000	250	270	2.542	2.493	0.7206
25 001 to 50 000	300	324	2.522	2.477	0.7255

2.13.3 Table 2.3 defines the minimum and maximum sample sizes, acceptability constants, and values of maximum standard deviation to be used for lots of various sizes being evaluated in accordance with the additional sampling provision of clause 2.4.3.

Table 2.3

N	n_{min}	n_{max}	k_1	k_2	MSD
500 or less	50	54	2.862	2.735	0.6504
501 to 1 000	100	108	2.684	2.601	0.6877
1 001 to 2 500	150	162	2.611	2.546	0.7043
2 501 to 5 000	200	216	2.570	2.514	0.7139
5 001 to 10 000	300	324	2.522	2.477	0.7255
10 001 to 15 000	400	432	2.494	2.456	0.7324
15 001 to 25 000	500	540	2.475	2.442	0.7371
25 001 to 50 000	600	648	2.462	2.431	0.7404

2.13.4 Table 2.4 defines the maximum permissible numbers of outliers and sample meters unavailable for testing associated with the four levels of acceptance for samples of various sizes being evaluated by the compliance sampling by variables method.

Table 2.4

n_{min}	o_1	o_2	o_3	o_4	n_1	n_2	n_3	n_4	n_5	c
25	0	0	0	1	1	1	2	2	0	0
50	0	0	1	2	1	2	3	4	1	0
75	0	1	1	2	2	3	5	6	1	0
100	1	1	2	3	2	4	6	8	1	0
150	1	2	2	3	3	6	9	12	2	0
200	1	2	3	4	4	8	12	16	2	0
250	1	3	4	5	5	10	15	20	3	0
300	2	3	5	6	6	12	18	24	3	0
400	2	4	6	7	8	16	24	32	4	0
500	3	5	8	9	10	20	30	40	5	1
600	3	6	9	10	12	24	36	48	6	1

2.13.5 Table 2.5 defines the upper and lower error tolerance limits for meter test point calibration accuracy associated with the four levels of acceptance for lots being evaluated in accordance with the compliance sampling plans.

Table 2.5

Tolerance limit	*j = 1*	*j = 2*	*j = 3*	*j = 4*
U_j	+2.0%	+2.5%	+2.75%	+3.0%
L_j	• 2.0%	• 2.5%	• 2.75%	• 3.0%

2.13.6 Table 2.6 defines the reverification period extension in years, according to meter type, associated with the four levels (j) of acceptance for lots being evaluated in accordance with the compliance sampling plans.

Table 2.6

Meter Type	*j = 1*	*j = 2*	*j = 3*	*j = 4*
Electricity Energy 1 or 1.5 element magnetic disk suspension (electro-mechanical type)	8	6	4	2
Electricity Energy 1 or 1.5 element non-magnetic disk suspension (electro-mechanical type)	5	3	2	1
Electricity Energy 2, 2.5, or 3 element magnetic disk suspension (electro-mechanical type)	6	4	3	2
Electricity Energy 2, 2.5, or 3 element non-magnetic disk suspension (electro-mechanical type)	5	3	2	1
Gas Volumetric (diaphragm type)	6	4	3	2

SECTION 07

Product Quality Audits

Contents

1. Scope

1.1 General

This document establishes the requirements in support of Measurement Canada's accreditation programs for the evaluation of quality systems and processes through product quality audits.

1.2 Applicability

The requirements of this document apply to product quality audits conducted by auditors who are either internal or external to the organization being audited.

1.3 Referenced Documents

S-S-01: *Statistical Methods for Metrological Control — Vocabulary and Symbols.*

S-S-02: *Statistical Methods for Metrological Control — Quality System Requirements.*

S-S-03: *Statistical Methods for Metrological Control — General Methods.*

S-S-04: *Statistical Methods for Metrological Control — Statistical Tests.*

1.4 Definitions

The definitions in document S-S-01 apply.

1.5 Responsibilities

1.5.1 Auditor Responsibilities. The auditor is responsible for:

(a) planning, implementing, reporting, and following up on product audits in accordance with the requirements of this document;

(b) performing all audit activities in accordance with documented and authorized procedures;

(c) evaluating the adequacy of documented investigations and resulting corrective actions;

(d) exercising objectivity in all inquiries, observations, and analysis pertaining to the audit; and

(e) in the case of an internal auditor, ensuring that he or she is independent of the product and associated processes being audited.

1.5.2 Auditee Responsibilities. The auditee is responsible for:

(a) developing, documenting. and maintaining a quality system in accordance with the requirements of document S-S-02;

(b) incorporating policies and procedures within its quality system documentation to support and facilitate the performance of product audits;

(c) providing all facilities, testing equipment, information, resources, and cooperation necessary for satisfactory completion of the product audit;

(d) investigating, through systematic means, the root causes of nonconformances discovered as a result of the product audit and promptly disposing of individual nonconforming products;

(e) evaluating the magnitude and extent of discovered nonconformances with respect to the particular product type being audited as well as to other product types which may have been logically affected due to common processes;

(f) documenting all details of the investigations and evaluations performed in clauses (d) and (e) above; and

(g) developing and documenting corrective actions, securing auditor acceptance, and implementing corrective actions in a timely manner.

2. Product Audit Focus

2.1 General

This section describes the objective, scope, and frequency requirements for the conduct of product quality audits.

2.2 Product Audit Objective

2.2.1 The primary objective of the product quality audit shall be to obtain sufficient quantifiable evidence to permit a judgement to be made of the auditee's compliance with the relevant quality system requirements and the effectiveness of existing controls as they pertain to the product(s).

2.2.2 The auditor and auditee shall make available all the resources necessary to fulfil their respective responsibilities during the product audit and to ensure the product audit objective is met.

2.3 Product Audit Scope

2.3.1 The scope of the product audit shall be established in manner consistent with the product audit objective.

2.3.2 In establishing the product audit scope, factors that shall be considered include but are not limited to:

(a) the variety of products produced by the auditee and the associated by-products;

(b) the scope and results of previous product audits;

(c) the period of time since the last product audit;

(d) changes to the auditee's quality system or processes;

(e) customer feedback regarding product quality; and

(f) nonconformances raised both internally and externally with respect to the products.

2.3.3 For measuring device products, product audits shall be performed at points in the process which enable process effects on product quality to be adequately assessed, including but not limited to such points as:

(a) selected in-process points - to assess aspects or characteristics of product which would require product disassembly or destruction if performed later in process;

(b) final inspection sites - to assess the capability of production to produce a quality product and the capability of final inspection process to correctly classify and quantify product quality;

(c) local storage sites - to assess handling and short-term storage effects, plus effects mentioned in item (b) as applicable;

(d) delivery sites or regional storage sites - to assess handling and transportation effects, plus storage effects and effects mentioned in item (c) as applicable; and

(e) installation sites - to assess handling, transportation, and installation effects, plus effects mentioned in item (c) or (d) as applicable.

2.4 Product Audit Frequency

2.4.1 Product audits shall be performed at times or intervals necessary to provide confirmation that product quality remains acceptable over time and to provide assurance that product quality is not adversely affected by process changes.

2.4.2 The auditor shall develop and document policies for product audit frequency, including the basis for the frequencies chosen.

2.4.3 The auditor's policies regarding product audit frequency shall be reviewed initially, and periodically thereafter, for adequacy by the auditor's management.

3. Product Audit Planning and Implementation

3.1 General

This section describes the planning, implementation, reporting, corrective action, and follow-up requirements for the conduct of product quality requirements.

3.2 Review of Auditee's Quality System

The auditor shall review the auditee's quality system documentation as a basis for planning the audit.

3.3 Product Identification

The auditor, in consultation with the appropriate managerial authority, shall establish the scope of the product audit in accordance with clause 2.3.

3.4 Auditee Contact

3.4.1 The auditor shall contact the auditee in advance of the product audit to determine who will represent the auditee during the audit.

3.4.2 The auditor shall establish a time table in association with the auditee for the conduct of the product audit.

3.5 Audit Plan

3.5.1 The audit plan shall be approved by the auditor's management prior to implementation.

3.5.2 The audit plan shall be designed to permit the auditor sufficient flexibility and time to pursue changes in emphasis as suggested by evidence gathered during the audit in view of the product audit objective.

3.5.3 The audit plan shall be documented and shall include the following information:

(a) the product audit objective and scope;

(b) an identification of the auditee organization and its representative;

(c) an identification of the auditor or audit team individuals and their assignments;

(d) an identification of reference documentation, materials, and equipment to be used during the conduct of the audit;

(e) the date(s) and location(s) of the audit;

(f) the estimated time to complete the audit;

(g) the schedule of meetings to be held with the auditee; and

(h) the expected completion date for the audit report.

3.5.4 Specific details of the audit plan which would compromise the collection of unbiased objective evidence shall be positively identified and shall not be prematurely communicated to the auditee.

3.6 Opening Meeting

3.6.1 A meeting of the auditor and the auditee's representative shall take place prior to the start of the physical audit activities.

3.6.2 The purpose of the meeting shall be to:

(a) introduce personnel involved in the audit;

(b) briefly review the audit objective, scope, and methods to be used;

(c) confirm that required resources and facilities are available; and

(d) confirm the time and date of the closing meeting.

3.7 Conduct of Audit

3.7.1 The auditor shall proceed with the physical activities according to plan.

3.7.2 During the audit, the auditor shall seek confirmation of any verbal or written representations made by auditee representatives regarding the system, process, or product by physical inspection of evidential matter or product, or by direct observation.

3.7.3 If the objective of the audit becomes unattainable for any reason, the auditor shall discontinue the audit and the reasons for the discontinuation shall be reported.

3.8 Observations

3.8.1 All observations, findings, inspection results, and test results obtained during the audit shall be documented.

3.8.2 Product properties or characteristics and their compliance with requirements shall be quantified in accordance with authorized product-specific procedures.

3.8.3 When testing metrological properties or characteristics of products, the auditor shall use only certified measurement standards and shall confirm the accuracy of these standards prior to their use.

3.9 Statistical, Metrological, and Quality Analyses

3.9.1 The auditor shall obtain the complete quality records and relevant process assessment and operational information for the product being audited from the auditee for analytical purposes.

3.9.2 Inspection and test results obtained by the auditor shall be compared to those obtained by the auditee and to the relevant product quality specifications.

3.9.3 Inspection and test result data shall be analyzed in accordance with the criteria of section 4 of this document and any references contained therein, with any nonconformance being unacceptable and cause for investigation and corrective action.

3.9.4 All analytical results, compliance assessments, interpretations, and associated comments shall be documented

3.9.5 A nonconformance report requesting investigation and corrective action shall be issued for each nonconformance or analysis with an unacceptable outcome.

3.9.6 A potential nonconformance report requesting monitoring of the situation shall be issued for each analysis with a marginally acceptable outcome.

3.10 Closing Meeting

A meeting of the auditor with the auditee management shall be held at the conclusion of the physical audit activities to:

(a) provide a preliminary report of the audit findings;

(b) discuss the actions to be taken both immediately and in the near term to resolve any nonconformances discovered; and

(c) indicate when the written report will be issued.

3.11 Product Audit Report

3.11.1 The auditor shall prepare a formal report consolidating and summarizing all audit observations, findings, inspection and test results, and nonconformance reports.

3.11.2 The product audit report shall contain the following information:

(a) the scope and objectives of the audit;

(b) key details of the audit plan including identification of the auditee organization and its representative, identification of the auditor or audit team individuals, identification of reference documentation, materials, and equipment used during the conduct of the audit, and the date(s) and location(s) of the audit and meetings held with the auditee;

(c) a description of the specific areas of compliance and noncompliance and a description of the areas where insufficient evidence was obtained to judge compliance or noncompliance;

(d) a description of the closing meeting communications in accordance with clause 3.10(b);

(e) an assessment of the extent of the auditee's compliance with the relevant quality system requirements; and

(f) an assessment of the effectiveness of existing controls for maintaining compliance and producing quality product.

3.11.3 The product audit report shall include as appendices the following information:

(a) copies of all observations, findings, inspection results, and test results required by clause 3.8.1;

(b) relevant extracts from the auditee's quality records and process information for the product being

audited as required by clause 3.9.1;

(c) copies of all analytical results, interpretations, and associated comments required by clause 3.9.4; and

(d) copies of all actual and potential nonconformance reports.

3.11.4 The completed audit report, including each actual or potential nonconformance report shall be signed and dated by the auditor.

3.11.5 A copy of the complete product audit report shall be provided to both the auditor's and auditee's management.

3.11.6 Audit reports shall be retained for the applicable period specified in the auditor's and auditee's quality system documentation.

3.12 Corrective and Preventive Action

3.12.1 The auditee shall investigate, determine the root causes of, and develop corrective and preventive actions for each nonconformance discovered during the product audit using disciplined problem solving methods.

3.12.2 The auditee shall investigate the duration and scope of systems-related nonconformances on the product type that was audited and product types sharing common processes, identify the products affected, and develop appropriate corrective and preventive actions.

3.12.3 The auditee shall keep the auditor informed of the status of corrective and preventive action activities.

3.12.4 The auditee shall implement and secure auditor acceptance of the developed corrective and preventive actions.

3.12.5 Details of all investigative, corrective, and preventive action activities specified in clauses 3.12.1 to 3.12.4 shall be documented and presented for auditor review, including dates of the activities, identification of processes and areas investigated, personnel involved, solutions considered and developed, and evaluation of corrective and preventive action effectiveness and the methods used for this evaluation.

3.12.6 The documentation referred to in clause 3.12.5 shall be retained in the auditee's quality records.

3.13 Auditor Follow-up

3.13.1 The auditor shall verify that the corrective and preventive actions developed have been implemented and are effective.

3.13.2 The auditor shall issue a documented addendum to the original audit report stating his or her findings with respect to clause 3.13.1.

4. General Technical Requirements

4.1 General

This section specifies the general technical requirements which apply in all product auditing situations.

4.2 Prerequisites

Before the methods of this section may be used to evaluate a product or process, the product audit shall have been planned and implemented according to the requirements of section 3 of this document.

4.3 Lot Formation

The product identified for audit shall be formed into a homogeneous lot for the purpose of sample selection.

4.4 Sample Selection

4.4.1 The sample shall be chosen from the lot by the auditor.

4.4.2 The size of the sample to be selected shall be determined in accordance with the criteria specified for the particular type of product audit situation.

4.4.3 Where random sampling is specified, the sample shall be selected from the lot based on either the random sampling method using tables of uniformly-distributed random numbers or the pseudo-random sampling method using an authorized computer algorithm for pseudo-random number generation.

4.4.4 Where uniformly-distributed random number tables are used, the coordinates of the initially selected value and the direction taken for selecting successive values shall be recorded.

4.4.5 Where pseudo-random sampling is used, the value of the seed shall be recorded.

4.5 Product Inspection and Quality Characteristics

4.5.1 Each sample unit of product shall be examined for conformance to all pertinent acceptance

requirements, according to the type of product.

4.5.2 Each sample unit of product shall be prepared for test and inspected in accordance with product-specific documented procedures which have been authorized by Measurement Canada.

4.5.3 All units of product identified for audit shall be inspected under identical conditions, within as short a time period as is practicable to achieve valid inspection results.

4.5.4 Where required in the product audit plan, replicated measurements of specified quality characteristics shall be performed.

4.5.5 The identification of each sample unit and the test results for each quality characteristic examined shall be documented.

4.6 Audit Sample Summary Values

4.6.1 For each qualitative characteristic inspected, a count of the number of nonconformities over the sample shall be made.

4.6.2 For each quantitative characteristic inspected, a count of the number of nonconformities or a calculation of one or more statistics over the sample shall be made, according to the product audit plan.

4.7 Acceptance Criteria

4.7.1 Inspection and test result data shall be analyzed in accordance with documented statistical test procedures, subject to the conditions specified in the procedures, and decisions shall be made according to the following criteria:

(a) a test statistic exceeding its 5% critical value is unacceptable and indicates investigation and corrective action is required;

(b) a test statistic exceeding its 10% critical value but not exceeding its 5% critical value is marginally acceptable and indicates monitoring of the situation is required; and

(c) a test statistic not exceeding its 10% critical value is acceptable.

4.7.2 Inspection and test result data shall be analyzed in accordance with documented product-specific metrological and quality criteria for deviations in individual results and for deviations from specification limits, with any deviation in excess of the applicable critical value being unacceptable and cause for investigation and corrective action.

4.8 Disposition of Nonconformances

4.8.1 Unacceptable populations or lots shall be contained, rectified, or recalled, as the case may be, and affected units may be resubmitted for inspection only after the organization has re-examined all of the units and removed or corrected all nonconforming or defective units.

4.8.2 Individual nonconforming or defective units may be resubmitted for evaluation only after all of their deficient characteristics have been corrected.

4.8.3 Process nonconformances shall be contained pending implementation of corrective and preventive action.

5. Audit of 100%-Inspected Product

5.1 General

This section specifies the technical requirements for the auditing of product which has been 100%-inspected.

5.2 Prerequisites

The prerequisites of clause 4.2 apply.

5.3 Lot Formation

The product identified for audit shall be formed into a homogeneous lot on the basis of the process used to produce it for the purpose of sample selection.

5.4 Sample Selection

In addition to the requirements of clause 4.4, the following apply.

5.4.1 The size of the sample to be selected shall be equal to 30 product units or all of the product available, whichever is less.

5.4.2 Where the lot size is greater than 30, the sample shall be selected using random sampling.

5.5 Product Inspection and Quality Characteristics

The product inspection and quality characteristic requirements of clause 4.5 apply.

5.6 Audit Sample Summary Values

5.6.1 For each qualitative characteristic inspected, a count of the number of nonconformities over the sample shall be made.

5.6.2 For each quantitative characteristic inspected, the statistics necessary to compare the means and variances of the sample values obtained from the auditee's records and from the audit inspection shall be calculated, based on the requirements contained in document S-S-04.

5.7 Acceptance Criteria

In addition to the requirements of clause 4.7, the following requirements apply.

5.7.1 Any count of one or more qualitative characteristic nonconformities shall be considered unacceptable.

5.7.2 The statistics required by clause 5.6.2 shall be compared to the acceptance criteria of clause 4.7.1 based on the statistical tests in document S-S-04 for:

(a) simultaneous comparison of means and variances;

(b) comparison of means using paired data; and

(c) comparison of variances.

5.8 Disposition of Nonconformances

The requirements of clause 4.8 apply.

6. Audit of Sampling-Inspected Product

6.1 General

This section specifies the technical requirements for the auditing of product which has been inspected by sampling.

6.2 Prerequisites

The prerequisites of clause 4.2 apply.

6.3 Lot Formation

The product identified for audit shall be based on homogeneous lots that were previously formed by the owner for the purpose of sampling inspection.

6.4 Sample Selection

In addition to the requirements of clause 4.4, the following apply.

6.4.1 Subject to clause 6.4.2, the size of the audit sample to be selected shall be equal to the size of the sample previously used for sampling inspection of the lot and shall involve the same sample product units previously inspected.

6.4.2 Where the audit sample size determined in accordance with clause 6.4.1 exceeds 40 units and where the audit plan specifically permits, the audit sample size may be reduced to 40 units which shall be randomly selected from the previously inspected product units.

6.5 Product Inspection and Quality Characteristics

The product inspection and quality characteristic requirements of clause 4.5 apply.

6.6 Audit Sample Summary Values

6.6.1 For each qualitative characteristic inspected, a count of the number of nonconformities over the sample shall be made.

6.6.2 For each quantitative characteristic inspected, the statistics necessary to compare the means and variances of the sample values obtained from the auditee's records and from the audit inspection shall be calculated, based on the requirements contained in document S-S-04.

6.7 Acceptance Criteria

In addition to the requirements of clause 4.7, the following requirements apply.

6.7.1 Any count of one or more qualitative characteristic nonconformities shall be considered unacceptable.

6.7.2 The statistics required by clause 6.6.2 shall be compared to the acceptance criteria of clause 4.7.1 based on the statistical tests in document S-S-04 for:

(a) simultaneous comparison of means and variances;

(b) comparison of means using paired data; and

(c) comparison of variances.

6.8 Disposition of Nonconformances

The requirements of clause 4.8 apply.